MANAGEMENT OF URD BEAN LEAF CRINKLE VIRUS WITH BOTANICALS

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Abstract

Six plant extracts viz., *Mirabilis jalapa, catharanthus roseus, Datura metal, Bougainvillea spectabilis, Boerhaavia diffusa* and *Azadirachta indica* were recorded maximum reduction of urd bean leaf crinkle virus (ULCV) incidence in urd bean crops at field level. Among the antiphytoviral chemicals tested, DHT reduced the transmission to the maximum extent and increased the incubation period of virus in the urd bean plant. Fresh buttermilk was significantly superior to fermented buttermilk in reducing the disease spread and increasing the incubation period of the virus in the plant. Casein was found effective in reducing the per cent transmission and increased the incubation period of the virus. Raising barrier crops viz., maize, sorghum and pearl millet were equally effective in reducing the spread of the disease in field. Spraying of DHT at two intervals, 7 and 22 DAS was found effective in reducing the disease spread when compared with Thuja, buttermilk, *M. jalapa* and neem oil.

Introduction

Urd bean (*Vigna mungo* (L.) Hepper) is an important pulse, very rich in protein (23.9%) and carbohydrate (60.4%) and is used in the daily diet of Indians. This pulse crop is grown all over India during summer and winter. Urd bean plant becomes a victim of a large number of diseases caused by both fungi and viruses. Among the virus diseases, Urd bean leaf crinkle virus (UCLV) is considered to be the most serious one causing considerable damage to the crop depending on season and variety cultivated. In India the disease was first reported by Chohan and Kalia (1967) from Punjab under the name 'curly top'. Kolte and Nene (1972) from Uttar Pradesh named the virus as 'Urd bean leaf crinckle virus'. It is reported to be a serious disease in the states of Uttar Pradesh (Nene, 1968), Punjab (Khatri *et al.,* 1971), Tamil Nadeu (Narayanasamy and Jaganathan, 1973), Himachal Pradesh (Gupta, 1974), Delhi (Amin *et al.*, 1978), Haryana (Singh *et al.*, 1979), and West Bengal (Chowdhury and Saha, 1985). Studies on management of urd bean leaf crinkle virus by using botanical, antiphytoviral chemicals and animal products are the important areas which needs focused research.

Materials and Methods:

Effect of chemicals, plant and animal products on infection

Pot culture studies using chemicals: Urd bean seeds of T9 variety were sown in pots of 9 inches in glasshouse and were thinned to five plants/pot. Aqueous solutions of 0.1%, DHT (2,4-dixohexahydro 1,3,5-triazine), carbendazim and benzoic acid, 0.02% salicylic acid acetyl salicylic acid and 2% Thuja (an aurvedic preparation) were sprayed on 10 day old seedlings. Plants were inoculated with infective sap at 24 hr before inoculation, 0 hr (mixing equal quantities of chemical and infective sap), 24 hr after inoculation and five days after inoculation. A total of 18 plants were inoculated for each treatment. Checks were maintained inoculating with infective sap alone. Number of infected plants and incubation period were recorded 30 days after inoculation to find out the effects of different chemicals on virus infection.

Pot culture studies with animal products three types of buttermilk samples viz., fresh, 1 and 2 day-fermented were taken and diluted to 10-fold with water. Casein was dissolved in small quantity of 0.1N NaOH and then diluted to 2, 3 and 4% with water. They were sprayed on urd bean plants following the method described under effect of chemicals.

Pot culture studies with plant products fresh leaves of Four-o' clock plant (*Mirabilis jalapa* L.), Algaroba (*Prosopis chilensis* (Molina) Stuntz.), Sadahdhatura (*Datura metel* L.), Coconut (*Cocos nucifera* L.), Sorghum (*Sorghum bicolor* (L.) Moench.), Bougainvillea (*Bougainvillea spectabilis* Wild.), Madagascar periwinkle (*Catharanthus roseus* (L.) G. Don.), Pongam (*Pongamia pinnata* (L.) Pierre.), Indian spinach (*Basella alba* L.), Horse-purslane (*Boerhaavia diffusa* L.), and Neem (*Azadirachta indica* A. Juss.), were collected. Coconut and sorghum leaves were air dried and ground into powder and the inhibitor was extracted by heating 10 g powder in 50 ml water at 70°C hot water bath for 30 min. The leaves of other plants were homogenized in a pestle and mortar by adding 4 ml of distilled water/g. The extract was then squeezed through muslin cloth and used for the experiment.

An equal quantity of each extract and infective sap were mixed and inoculated on urd bean seedlings of 10 days old. The control plants were inoculated with infective sap alone. Thirty plants were inoculated for each plant extract. Number of infected plants, incubation period and percent infection were recorded.

In field: Field trials were conducted in kharif 1988 with 0.1% DHT. 2% Thuja, 10% fresh buttermilk and leaf extracts of Four-o' clock plant *(Mirabilis jalapa)*. Leaf material from healthy *M. jalapa* plants was collected and macerated with water at 5 lt/kg. The resultant pulp was passed through two folds of muslin cloth and made up to 10 lt. To 1 lt water, 10 ml Neem oil and 1 ml teepol was added and shaken well to emulsify the soil. They were sprayed on plants with a knapsack sprayer until drip off occurred. The control plots were sprayed with water. Two sprays were given on 7 and 22 days after planting (DAP). The numbers of diseased plants were counted at weekly intervals from 20 to 60 DAS. The crop was not sprayed with any insecticide or fungicide. Experimental plot size was 4 x 3 m in four replications.

Barrier crops

Maize (Ganga 5), sorghum (Co. 26) and pearl millet (Co. 6), urd bean T9 were sown against the wind direction in two rows each on north and south sides of the urd bean plot in kharif season, 1988. Between them, the control plot was eight rows of urd bean without barrier crop. Between two treatments, three rows of urd bean seeds were sown to serve as outskirts. The plot size was 4 x 5 m with five replications. The spacing was 30 x 10 cm for urd bean, 60 x 30 cm for maize and 45 x 15 cm for sorghum and pearl millet. The number of infected plants was recorded at weekly interval from 25 to 60 DAS. The percentage of infection was calculated based on plot population. The grain yields of urd bean and barrier plants were recorded.

Results and discussion

Effect of chemicals, plant and animal products under pot culture condition

Plant extracts: Since the antiviral principles (AVP) present in leaf extracts of several plants are known to inhibit infection by many viruses, the efficacy of 11 plant extracts on the percent transmission of this virus was tested. It was observed that the leaf extract of *Mirabilis jalapa* reduced the 30 per cent transmission as against 80% in control followed by *Catharanthus roseus* (40%). *Datura metal*, *Bougainvillea spectabilis*, *Boerhavia diffusa* and *Azadirachta indica* each 50% infection (Table-1). All the leaf extracts increased the incubation period. However, the maximum increase of 8.8 days was recorded by *Mirabilis jalapa* leaf extract.

The AVP present in leaf extracts of several plants are known to inhibit infection by the viruses (Rayachaudhuri and Prasad, 1965; Varma, 1974; Singh and Singh, 1975; Narayanasamy and Ramaiahl 1983). Antiviral principles from *M. Jalapa* (Murthy, 1982), *Prosophis specigera* (Nagarajan and Murthy, 1977), *Bougainvillea spectabilis* and *Basella alba* (Murthy et al., 1981) were found effective against TMV. Chowdhury and Saha (1985) found that the Urd bean leaf crinkle virus (ULCV) was inhibited by *D. metal* leaf extract to the extent of 30 % over control. It was observed that *M. jalapa* has shown better inhibition (30 %) than *D. metal* (50 %). The effect has been attributed to inhibitory principles present in the leaf extracts. Consequently, the number of virus particles entering the plant might have been reduced. Similar observation was made by White and Antoniw (1983) indicating that inhibitors of plant virus infections may affect plants directly or interfere with a host-virus interaction, which is essential for infection. Prasad (1986) observed some alterations in enzyme activity during induced antiviral state. These are some of the possible ways by which the plant extract prevent virus diseases.

The results obtained in the present investigation have indicated a great potential of plant extracts for the management of the disease. Further work to identify the active component involved and its purification and formulation will offer a practical method of virus disease management.

Effect of antiphytoviral chemicals: It was observed that DHT, benzoic acid, carbendazim and Thuja significantly reduced the per cent transmission over control. (Table 2) showing the plants treated with DHT, Carbendazim and Thuja recorded only 48, 57 and 50% mean infection respectively compared to 77 in control. The time of application of these chemicals did not significantly influence infection. The lowest (25%) percent infection was observed when DHT was mixed with the inoculum. All chemicals except benzoic acid delayed the onset of symptoms significantly over control.(Table 2). DHT delayed symptom expression by 7.5 days when mixed with the inoculum. When the time of application of the chemicals was considered, the incubation period significantly increased, when the chemicals were applied at all times except 5 days after inoculation. The maximum increase in incubation period was 21 days when chemicals were mixed with the inoculum were applied. There was significant interaction between inoculation time and chemicals (Table 2)

Considering the fact that it is virtually impossible to free plants from virus after infection, research was directed at reducing the disease severity and preventing virus establishment by use of chemicals that do not affect host plants. Antiviral chemicals can act in various ways either by complexing chemically modifying and / denaturing, dissociating, hydrolyzing or precipitating viruses. Many chemicals were reported to act as inhibitors of virus replication in plants. Schuster *et al.* (1979) showed marked decrease in the concentration of PVX, PVY and CMV in tobacco plants when sprayed with DHT two days before inoculation and 2-7 days after inoculation. Periodical assay of the treated plants for the titre of the virus will throw light on the mechanism of action of DHT against the present virus.

Similarly, carbendazim reduced percent infection while incubation period was prolonged when applied as foliar spray 24 hours before and 24 hours and five days after inoculation (Table 2). Tomlinson *et al* (1976) has reported treatment of tobacco and lettuce plants with carbendazim-prevented development of two virus diseases namely bean Western yellows and TMV in lettuce and tobacco respectively. The effectiveness of benlate in reducing the transmission of ULCV was reported by Bhardwaj *et al.*, (1982). Although the mode of action of benzimidazoles in suppressing symptoms is not clearly understood, it is known that these compounds can bind to chloroplast membrane and delay chloroplast senescence and act like cytokinins (Waygood, 1965; Tripathi and Schlosser, 1977). It is therefore, possible that the symptom suppressive effect of benlate is due to its cytokinin and antisenescent properties.

Buttermilk: Since the protein present in skim milk has been reported to reduce transmission of TMV, the influence of buttermilk, which also contains casein, on transmission of this virus was studied in a pot culture experiment. It was seen from Table 3 that there was significant reduction in per cent infection by all types of buttermilk over control. Fresh buttermilk gave the lowest transmission of 44.5% as compared to 83.4% in control. There was significant difference between the types of buttermilk used. Fresh buttermilk was significantly superior to fermented buttermilk.

Among the different times of application of buttermilk, the lowest infection was obtained when it was applied to the plant by mixing with infective sap, followed by before 24 hr and after 24 hr inoculation. The interaction between the time of application and buttermilk types was not significant. The incubation period also increased significantly over control in all types of buttermilk tested. Fermentation of buttermilk for 48 hr delayed onset of symptoms to the maximum extent *viz*., 3.9 days followed by 3.0 days in 24 hr fermented buttermilk. There was significant increase in incubation period when buttermilk types were applied at different times as compared to control. The highest incubation period of 22.52 days was recorded with buttermilk mixed with inoculum followed by 18.5 days when buttermilk was applied before 24 hr compared to 16.5 days in control. The interaction between time of application and buttermilk types was not significant.

The reduction in disease due to buttermilk was probably due to the blocking of receptor sites by the protein present in buttermilk or due to the inhibition of virus multiplication or both. The former might have lead to reduction in disease while prolonged latent period was due to decreased rate of multiplication of the virus in the plant after infection. However, it is difficult to pin point the exact reasons.

Tomaru and Ohkawa (1985) have reported casein inhibited transmission of CMV to tobacco by *M. persicae*. Buttermilk contained 3.1 g protein / 100 g (Gopalan *et al*., 1985). Another possible cause for reduced transmission by using buttermilk may be the pH. The present study revealed that when buffer with pH less than 5 was used for sap transmission, only 16.6 % inoculated plants were infected against 80% in buffer of pH 7.5 (Fig. 1). This indicates that the buffer in acid range is inhibitory to the virus. Therefore the inhibitory effect by fresh and fermented buttermilk can be attributed to the acidic pH in the range of 4.4 – 3.9.

Casein: Since the protein present in buttermilk is casein, the effect of this proximate constituent on transmission of the virus was studied. From data presented in Table 4, it can be seen that among the different times of application, mixing inoculum with casein gave the lowest infection per cent transmission *viz*., 54.2 against 89.9% in control. Other periods of application did not significantly reduce transmission. The interaction between time of application and types of buttermilk was not significant.

The incubation period in all the treatments increased significantly when compared to control. It was slightly increased by 3.4, 3.8 and 3.9 days over control at 2, 3 and 4% concentrations, respectively. It increased by 2.5 and 6.0 days over control when buttermilk types applied before 24 hr and inoculum was mixed with casein respectively. The interaction between time of application and chemicals was significant.

Hein (1964) protected lettuce seedlings from lettuce mosaic virus transmitted by *M. persicae* by spraying whole milk on both source and test plants. In 1965, she demonstrated that the effective ingredient was the milk fat and also observed inhibition of the transmission of celery mosaic virus by M. *persicae*. Hein (1975) reported that there was reduction in spread of carnation vein mottle virus when sprayed with skim milk +

maize oil + Metasystox. In a field trial, Murthy and Nagarajan (1986) observed that 1% milk reduced the spread of TMV in tobacco.

Effect of chemicals, plant and animal products under pot culture condition

The disease incidence recorded in different treatments in the field is presented in Table 5. The data showed that DHT reduced the disease spread to the maximum extent (9.01%) compared to control (1.47%). However all the other materials tested were also effective in reducing the disease spread significantly over control. The interaction between days and treatments was found non-significant.

Using this chemical in field, Schuster and Hanzsch (1981) reduced spread of potato viruses. This chemical protected tobacco plants against PVX for prolonged period (Schuster and Kramer, 1982). Combined application of DHT was ribavirin retarted multiplication of PVX in tobacco (Schuster, 1982). Spraying of Thuja, plant extract and buttermilk also reduced the disease significantly over control. The reduction in disease due to these treatments and their probable mode of action was discussed earlier.

Neem oil tested in this study reduced the disease incidence. The spread of the virus diseases reduced by application of plant oils has been reported by several workers (Nene, 1973; Singh and Varma, 1977; Sharma and Varma, 1982). Neem oil was reported to possess an adverse effect on some vectors, significant reduction in food intake by *N. virescence* in rice due to this oil was noted by Mariappan and Saxena (1983). Neem oil was presumed to contain antifeedant and repellant properties. Varma (1974) identified two compounds viz., nimdin and nimbin in neem oil which inhibited local lesion formation. Coudriet *et al*., (1985) reported that neem seed extract repelled whitefly from alighting on cotton. Thus, the field experiment has corroborated the results obtained from pot culture trials.

Effect of barrier crops on disease spread

To select a suitable barrier crop for reducing the spread of the disease, a field trial was conducted and the observation revealed that all the three barrier crops were found equally effective in reducing the spread of the disease significantly over control (Table 6). The mean percentage of disease incidence was 3.17, 2.91 and 3.59 in maize, sorghum and pearl millet barriers respectively, whereas in control it was 6.39%. There was no significant difference among the treatments. The per cent disease increase was observed only up to 42 DAS. After that, there was no significant increase in disease incidence in plots with barrier crops. But the control plots recorded double the per cent incidence even after 42 DAS.

Thresh (1976) stated that incoming vectors tend to alight on the plants in the border forming edge effects. Singh (1985) reported that maximum protection by barrier will depend on many factors such as vigour, thickness and height of barriers, environmental factors like the wind velocity, direction and growth of the crop. The low disease incidence noted in the present study in plots with barriers can be attributed to the

faster growth of the barrier crops than urd bean in early stages it might have prevented the vector landing on the main crop.

The reduction in disease spread by using barrier crops has been reported by several workers. Simons (1957, 1960) found that the use of barrier crops like sunflower and snap beans reduced the incidence of pepper vein-banding mosaic virus and PVY in chillies in Florida. Similarly in Punjab, Deol and Rataul (1978) reported that the use of barrier crops, viz., sunflower, gingelly, sorghum and pearl millet reduced the spread of CMV in chilli and also increased the yield over control. Sridhar (1986) reported that sunflower, sorghum and maize barriers reduced the incidence of CMV in chilli transmitted by aphids. Ravinder Babu (1987) reported reduction in MYMV spread in mungbean crop by growing pearl millet and sorghum as barriers. From this it can be concluded that barrier crops offer an effective solution in reducing spread of the virus.

In this connection, it may be mentioned that urd bean in many parts of the state is usually grown as a mixed crop by farmers along with sorghum and pearl millet. The present finding from the study has provided experimental proof of the efficiency of barrier crops in reducing the spread of the disease under field conditions.

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Table 1: Effect of plant extracts on ULCV transmission

Plant species	Plants infected out of 10	Incubation period(days)	Percent infection
Mirabilis jalapa	3	26.6	30(32.7)
Prosophis chilensis	6	23.0	60(50.7)
Datura metel	5	26.0	50(45.7)
Cocos nucifera	7	20.4	70(56.3)
Sorghum bicolor	7	20.8	70(56.3)
Bougainvilla spectabilis	5	26.2	50(45.5)
Carthamus roseus	4	26.3	40(39.4)
Pongamia pinnata	6	21.4	60(50.7)
Basella alba	6	22.0	60(50.7)
Boerhaavia diffusa	5	23.3	50(45.7)
Azadirachta indica	5	23.0	50(45.7)
Control	8	17.8	80(62.7)

C.D (P=0.05)

Figures in parenthesis are transformed values

Table 2: Effect of antiphytoviral chemicals on ULCV transmission by sap

Chemicals	Percent infection of ULCV					Incubation period (days)				
	A	B	C	D	Mean	A	B	C	D	Mean
DHT	50.0 (44.98)	25.5 (27.80)	61.2 (51.46)	55.6 (48.22)	48.1 (43.07)	21.5 (4.61)	25.5 (5.06)	20.5 (4.06)	18.0 (4,24)	21.4 (4.64)
Acetyl Salisalic acid	77.8 (62.15)	72.3 (58.43)	77.8 (62.15)	77.8 (62.11)	77.1 (61.18)	18.0 (4.24)	20.0 (4.47)	21.5 (4.61)	19.5 (4.43)	19.8 (4.44)
Salisalic acid	61.2 (51.46)	72.3 (58.43)	72.3 (58.43)	61.2 (51.46)	80.1 (64.94)	20.5 (4.50)	20.5 (4.54)	18.0 (4.24)	18.0 (4.24)	19.3 (4.38)
Benzoic acid	61.2 (51.46)	50.0 (44.98)	55.6 (48.22)	53.4 (48.22)	53.4 (46.67)	18.0 (4.24)	18.0 (4.24)	18.0 (4.24)	18.0 (4.24)	18.0 (4.24)
Carbendazim	55.6 (48.22)	77.8 (62.15)	50.0 (44.97)	44.5 (41.73)	57.3 (49.22)	22.0 (4.68)	21.0 (4.58)	20.0 (4.47)	19.0 (4.35)	20.5 (4.52)
Thuja	44.5 (41.73)	44.5 (41.73)	50.0 (44.97)	61.2 (51.46)	50.1 (44.98)	22.0 (4.68)	23.0 (4.78)	21.0 (4.58)	19.5 (4.43)	21.4 (4.58)
Control	77.8 (62.15)				77.8 (68.15)	18.0 (4.24)				18.0 (4.24)
Mean	54.25 (47.41)	52.25 (41.82)	48.2 (49.79)	60.25 (50.91)		20.75 (4.14)	22.04 (4.71)	20.4 (4.04)	19.0 (4.35)	

C.D. (P = 0.05)

Figures in parenthesis are transformed values

A = 24 hr before inoculation; B = 0 hr inoculation; C = 24 hr after inoculation; and D = 5 days after inoculation

Hours	NS	0.07
Chemicals	5.42	0.08
Hours x chemicals	10.86	0.17

Table 3: Effect of buttermilk on ULCV transmission by sap

Type of buttermilk	Percent infection of ULCV					Incubation period (days)				
	A	B	C	D	Mean	A	B	C	D	Mean
Fresh	44.5 (41.73)	22.3 (27.80)	44.5 (41.73)	66.7 (55.18)	44.8 (41.61)	17.5 (4.43)	22.5 (5.01)	18.5 (4.33)	16.5 (4.12)	18.8 (4.49)
24 hr fermented	55.6 (48.22)	44.5 (41.73)	55.6 (48.22)	66.7 (33.18)	55.4 (48.34)	19.5 (4.54)	24.8 (5.09)	17.5 (4.43)	16.5 (4.18)	19.6 (4.54)
48 hr fermented	44.5 (41.73)	50.0 (44.97)	44.5 (41.73)	83.4 (66.21)	55.6 (48.67)	20.5 (4.56)	26.6 (4.99)	17.5 (4.41)	17.0 (4.28)	20.4 (4.56)
Control	83.4 (65.87)				83.4 (65.87)	16.5 (4.12)				16.5 (4.12)
Mean	57.0 (49.39)	50.1 (45.0)	57.0 (49.0)	75.1 (64.25)		18.5 (4.51)	22.5 (5.03)	17.5 (4.36)	16.6 (4.21)	

C.D. (P = 0.05)

Figures in parenthesis are transformed values

A = 24 hr before inoculation; B = 0 hr inoculation; C = 24 hr after inoculation; and D = 5 days after inoculation

Hours	7.18	0.06
Buttermilk type	6.21	0.05
Hours x chemicals	NS	NS

Table 4: Effect of casein on ULCV transmission by sap

Concentration	Percent infection of ULCV					Incubation period (days)				
	A	B	C	D	Mean	A	B	C	D	Mean
2	83.4 (66.25)	44.5 (41.73)	77.8 (62.15)	88.9 (69.98)	73.7 (60.03)	19.8 (4.16)	25.0 (4.76)	15.0 (4.32)	17.5 (4.08)	20.1 (4.33)
3	83.4 (66.25)	38.9 (38.49)	88.9 (69.98)	88.9 (69.98)	75.1 (61.17)	20.6 (4.43)	25.9 (4.96)	19.0 (4.32)	17.5 (4.08)	20.8 (4.42)
4	77.8 (62.15)	44.5 (41.73)	88.9 (69.98)	88.9 (69.98)	75.1 (60.96)	20.6 (4.54)	25.0 (5.16)	19.5 (4.16)	18.8 (4.12)	20.9 (4.49)
Control	88.9 (69.98)				88.9 (69.98)	17.0 (4.08)				17.0 (4.08)
Mean	83.3 (64.89)	54.2 (40.65)	86.2 (67.37)	88.9 (69.98)		19.5 (4.38)	23.0 (4.96)	18.6 (4.22)	17.7 (4.09)	

C.D. (P = 0.05)

Figures in parenthesis are transformed values

A = 24 hr before inoculation; B = 0 hr inoculation; C = 24 hr after inoculation; and D = 5 days after inoculation

Hours	7.84	0.06
Buttermilk type	NS	0.06
Hours x chemicals	NS	0.12

Table 5: Effect of chemicals, plant extract and animal products on ULCV disease spread and yield

Treatments	Percent disease incidence DAS						
	28	35	42	49	56	Mean	Yield (kg/ha)
DHT	0.09 (2.15)	0.89 (5.38)	1.07 (5.89)	5.89 (14.01)	9.01 (17.46)	3.39 (8.98)	876
Thuja	0.27 (3.01)	1.07 (5.89)	1.97 (8.01)	6.52 (14.76)	11.16 (19.49)	4.19 (10.24)	868
M. Jalapa	0.18 (2.58)	0.81 (5.05)	1.79 (7.63)	6.43 (14.73)	10.81 (19.25)	4.01 (9.85)	862
Buttermilk	0.09 (2.15)	0.72 (4.76)	1.43 (6.79)	6.43 (15.63)	10.45 (18.84)	3.84 (9.43)	860
Neem oil	0.26 (3.01)	0.81 (5.11)	1.34 (6.64)	5.09 (12.77)	11.51 (19.81)	3.81 (9.47)	864
Control	1.07 (6.64)	1.63 (8.15)	2.86 (10.88)	9.20 (17.64)	14.47 (22.35)	5.85 (13.13)	856
Mean	0.33 (3.25)	0.99 (5.73)	1.75 (7.64)	6.59 (14.76)	11.24 (19.53)		

C.D. (P = 0.05)

Days	=	0.49
Treatments	=	0.54
Days x chemicals	=	NS

Table 6: Effect of barrier crops on disease incidence (%) and grain yield

Barrier crops	DAS					Mean	Yield(kg/ha)	
	28	35	42	49	56		Urd bean	Barried crops
Maize *(Zea mays)*	1.43 (6.67)	2.50 (8.96)	3.43 (10.53	4.14 (11.62)	4.28 (11.83)	3.17 (9.92)	626	514
Sorghum *(Sorghum bicolor)*	1.22 (6.16)	2.22 (8.44)	3.22 (10.22)	3.93 (11.33)	3.93 (11.33)	2.91 (9.49)	638	486
Pearl millet *(Pennisetum americanum)*	1.22 (6.21)	2.64 (9.34)	3.86 (11.28)	5.07 (12.98)	5.14 (13.16)	3.59 (10.59)	658	322
Control	1.07 (5.83)	2.64 (9.33)	4.07 (11.63)	10.86 (19.02)	13.32 (21.18)	6.39 (13.39)	822	--
Mean	1.24 (6.22)	2.50 (9.02)	3.65 (10.92)	6.00 (13.74)	6.67 (14.37)			

C.D. (P = 0.05)

Days = 0.76
Crops = 0.68
Days x crops = 1.52