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Evaluation of Three Botanicals, Bavistin and BAU-Biofungicide for Controlling Leaf Spot of Groundnut Caused by *Cercospora arachidicola* and *Cercosporidium personatum*

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Abstract

A study was conducted to evaluate the effectiveness of three selected botanicals namely leaf extract of Neem (*Azadirachta indica*), Debdaru (*Polyalthia longifolia*) and datura (black) (*Datura metel*) along with Bavistin (Carbendazim) and BAU-biofungicide (*Trichoderma harzianum*) against leaf spot disease (tikka) of groundnut caused by *Cercospora arachidicola* and *Cercosporidium personatum* at the Field Research Farm of Bangladesh Agricultural University, Mymensingh during 2009-10. The most effective treatments were Bavistin, BAU-biofungicide (seed treatment + spray), BAU-biofungicide (spray) and leaf extract of Neem. Bavistin increased pod and dry haulm yield by 53.51 and 24-80 %, respectively. Maximum pod yield and dry haulm weight were recorded under Bavistin. BAU-biofungicide (seed treatment + spray) produced the second highest pod and dry haulm yield followed by leaf extract of Neem and BAU-biofungicide (spray). BAU-biofungicide (seed treatment + spray) and leaf extract of Neem may be recommended for controlling leaf spot disease of groundnut.

Keywords: Groundnut, leaf spot disease, Botanicals, BAU-biofungicide and Bavistin

1. Introduction

Groundnut (*Arachis hypogaea* L.) is an important annual photo insensitive legume crop grown in many tropical and subtropical countries of the world (Wudiri and Fatoba, 1992). More than 40 fungal diseases attack the crop throughout the world (Jackson and Bell, 1969). In Bangladesh, it is subjected to attack by at least 18 diseases (Bakr and Ahmed, 2009). Among the diseases, early leaf spot caused by *Cercospora arachidicola* Hori and late leaf spot caused by *Cercosporidium personatum* are the most important foliar diseases of the crop. Both of them are commonly known as Tikka disease.

The damages caused by the disease include defoliation, reduction in number of pods and haulm yield and deterioration of quality of seeds and increase in cost of production (Brennemen and Culbreath, 2000). In Bangladesh, loss in yield of pod ranged from 30-40% in variety Dhaka-1 (Hossain *et al.,* 2005). In India, loss in pod yield due to the disease was recorded as 70 % in groundnut (Subrahmanyam *et al*., 1980).

Various strategies have been suggested for the control of the disease. However, chemical method is the most efficient and economic way of controlling the disease all over the world (Smith and Littrell, 1980; Culbreath *et al.,* 2002).

Considering harmful impact of fungicides on environment and human health, use of alternative methods is necessary.

Now a days, control of plant disease by biological means as drawn special attention all over the world. Biological control has been proposed as a substitute of chemical control against plant disease (Harman, 2000). Biological control represents a less cost, environmental friendly natural and ecological approach for controlling diseases and it reduces chemical inputs and their effect on environment. Available reports suggest that exploiting botanicals with antifungal activity offers an economic, safe and easily available alternative method for the management of leaf spot of groundnut (Rahman and Hossain, 1996). Botanicals were also found to be effective against leaf spot disease of groundnut (Aage *et al.*, 2003). The present study was therefore, undertaken to evaluate three botanicals along with BAU-biofungicide and Bavistin on leaf spot of groundnut under natural epiphytotic conditions.

2. Materials and Methods

The experiment was conducted in the Field Research Farm, Department of Plant Pathology, Bangladesh Agricultural University (BAU), Mymensingh during November 2009 to May 2010 to evaluate three selected botanicals, BAU-biofungicide and Bavistin against leaf spot (tikka) disease of groundnut. Treatments such as Bavistin 50WP (Carbendazim) (0.1%), BAU-biofungicide (2.5 %) (*Trichoderma harzianum* based preparation), leaf extract of Neem (*Azadirachta indica*) @ 25% (w/v), Debdaru (*Polyalthia longifolia*) @10 % (w/v) and Datura (black) (*Datura metel*) @ 20 % (w/v) were used. The experiment was carried out by using Randomized Complete Block Design (RCBD) with three replications. Suspension of all materials was used as foliar spray. Additional two treatments were maintained where seeds were treated with BAU-biofungicide, and seed treatment and foliar spray with the biofungicide. So, there were altogether eight treatments including a control. Seeds were treated with BAU-biofungicide (2.5% of seed weight) as per recommended by Naznin and Hossain (2004). The spray was started from 88 days after sowing and continued for 5 times at 19 days before harvest. The sprays of fungicide, botanicals and BAU-biofungicide were applied at 15 days interval with the help of a self compressed hand sprayer to cover the foliage parts of plants.

The individual size of the plot was 3.5 m x 1.6 m. The seeds of groundnut variety Dhaka-1 were sown @ 110 kg ha^{-1} maintaining seed to seed and line to line distances 10 cm and 40 cm, respectively on November 25, 2009. Fertilizers were applied @ 10:70:50:30 and 2 kg ha^{-1} N: P: K: S and B in the form of Urea, TSP, MoP, Gypsum and Boric acid, respectively. Cow dung was applied @ 10 t ha^{-1}(DAE, 1985). Half of urea, the entire amount of TSP, MoP, gypsum, boric acid and cow dung were applied at the time of final land preparation. The reaming amount of urea was top dressed at 55 days after sowing. The crop was irrigated whenever necessary. Intercultural operations were done as and when necessary for the normal growth of the crop.

Data on plant height, number of total, infected and defoliated leaves $plant^{-1}$, number of lesion $leaf^{-1}$ and leaf spot incidence (%) were recorded. Incidence of leaf spot under different treatments was calculated following the formula stated below (Subrahmanyam *et al.*, 1995) as:

$$\text{Leaf spot incidence (\%)} = \frac{\text{Number of infected leaves plant}^{-1}}{\text{Total number of leaves plant}^{-1}} \times 100$$

The crop was harvested after 167 days of sowing on May 10, 2010. After harvest, data on number and weight of total, mature and immature pods $plant^{-1}$, weight of 100-pods, dry haulm and shelling (%) were also recorded. All data were analyzed statistically following MSTAT- C computer program.

3. Results and Discussion

All treatments gave significant increase in different growth parameters over control (Table 1). The leaf spot incidence (%) of different treatments differed significantly among themselves. The leaf spot incidence ranged from 12.9 to 36.4 % under different treatments including control. The lowest incidence was recorded from Bavistin followed by BAU-biofungicide seed treatment + spray; leaf extract of *A. indica* and BAU-biofungicide spray. The plant height varied from 57.5- 66.5 cm. The highest and the lowest plant heights were recorded from BAU-biofungicide seed treatment + spray and control, respectively. All the treatments gave higher total number of leaves plant^{-1} over control. Maximum total number of leaves plant^{-1} was produced by Bavistin, which was statistically similar to BAU-biofungicide seed treatment + spray and leaf extract of *Azadirachta indica* and *Datura metel*. Maximum number of infected leaves plant^{-1} were recorded under untreated control and minimum in Bavistin treated plot followed by BAU-biofungicide seed treatment + spray and BAU-biofungicide spray treated plots. Leaf extract of *A. indica* showed similar effects as Bavistin. Maximum number of lesions leaf^{-1} was observed under control. The number of lesions leaf^{-1} was significantly reduced by the treatments with Bavistin, BAU-biofungicide seed treatment + spray, extract of neem leaf and BAU-Biofungicide spray.

The number of defoliated leaves plant^{-1} differed significantly and ranged from 15.4 to 33.3. Maximum number of defoliated leaves plant^{-1} was recorded from control and minimum in Bavistin, followed by BAU-biofungicide seed treatment + spray and leaf extract of *A. indica* and BAU-biofungicide spray. The findings are in agreement with the finding of Aage *et al*. (2003). Similar results have also been reported by Natarajan *et al*. (2005); Kishore and Pande (2005) and Abdulrahman and Aikali (2005). The extracts of *A. indica*, *D. metel* and *Trichoderma* based preparation reduced leaf spot incidence up to 65% and disease rating on 1-9 scale under field conditions was comparable with the commercial fungicide Bavistin (Ihejirika *et al.*, 2006). The lowest leaf spot incidence was recorded in *A. indica* compared to untreated control.

Table 1. Effect of three selected botanicals, Bavisitin and BAU-biofungicide on leaf spot incidence, plant height, number of total, infected and defoliated leaves plant^{-1} and number of lesions leaf^{-1} of groundnut

Treatments	Leaf spot incidence (%)	Plant height (cm)	Number of total leaves plant^{-1}	Number of infected leaves plant^{-1}	Number of lesions leaf $^{-1}$	No. of defoliated leaves plant^{-1}
Datura metel (spray)	23.6	63.3	161.7	38.1	11.7	27.0
Azadirachta indica (spray)	15.5	63.2	158.2	26.7	9.0	17.8
Polyalthia longifolia (spray)	21.0	62.1	151.9	31.9	10.7	24.3
BAU-biofungicide (seed treatment)	23.8	65.0	149.8	35.7	14.1	26.8
BAU -biofungicide (spray)	16.0	63.1	155.3	24.8	9.8	18.4
BAU -biofungicide (seed treatment + spray)	13.7	66.5	157.3	21.6	9.4	17.0
Bavistin (spray)	12.9	65.1	162.5	20.9	7.8	15.4
Control (untreated)	36.4	57.5	133.4	49.2	18.8	33.3
LSD ($P \geq 0.01$)	3.27	4.61	5.59	5.87	3.44	3.73

Data represent the mean of three replications, where 10 plants replication^{-1} were counted.

These results are consistent with the reports of Bdliya and Aikali (2008) and Patni *et al.* (2005). Aage *et al.* (2003) found that fourth spray of aqueous leaf extract of *A. indica* was highly effective in suppressing disease intensity of groundnut. Bdliya and Aikali (2008) stated that plant extracts reduced the incidence and severity of *Cercospora* leaf spot compared to the untreated crops. In treated plots with BAU-Biofungicide and extract of *A. indica*, leaf extract of *Lycopersicon esculentum* and *Polyalthia longifolia*, there were reduction in leaf spot incidence indicating that defoliation can be minimized by controlling lesion development on the leaves which is supported by Pande *et al*. (2001).

The number of total pods plant^{-1} ranged from 38.0 to 50.9. The highest number of pods plant^{-1} was recorded from leaf extract of *A. indica* treated plants followed by Bavistin, BAU-biofungicide spray, BAU-biofungicide seed treatment + spray and BAU-biofungicide seed treatment, where as the lowest was found under control (Table 2). The number of mature pods plant^{-1} ranged 30.2 to 45.0. The highest number of mature pods plant^{-1} was recorded under Bavistin, which was statistically similar to leaf extract of *A. indica* spray, BAU-biofungicide seed treatment + spray and BAU-biofungicide spray. The lowest number of mature pods plant^{-1} was found under control. BAU-biofungicide seed treatment + spray produced the lowest number of immature pods plant^{-1}. All the treatments gave significant increase in total and mature pod weight over control. Under all the treatments excluding control, weight of total and mature pods plant^{-1} range from 31.4 to 38.2 and 28.6-35.1 g plant^{-1}, respectively. Maximum weight of total and mature pods was achieved with Bavistin followed by BAU-biofungicide seed treatment + spray, BAU-biofungicide spray and spray of leaf extract of *A. indica*. The weight of immature pods varied from 2.1 to 3.1 g plant^{-1}. The lowest weight of immature pods plant^{-1} was recorded under BAU-biofungicide seed treatment, which was statistically similar to leaf extract of *A. indica*, BAU-biofungicide seed treatment + spray, BAU-biofungicide spray and control. Observation made by Subrahmanyam *et al.*, (1984) and Gwary and Asala (2006) also supported the present findings.

Table 2. Effect of three selected botanicals, Bavistin and BAU-biofungicide on number and weight of pods plant^{-1} of groundnut

Treatments	Number of pods plant^{-1}			Weight of pods plant^{-1} (g)		
	Total pods	Mature pods	Immature pods	Total pods	Mature pods	Immature pods
Datura metel (spray)	41.0	33.9	7.1	31.4	28.6	2.8
Azadirachta indica (spray)	50.9	44.7	6.2	34.8	32.5	2.3
Polyalthia longifolia (spray)	43.5	35.0	8.5	32.7	29.6	3.1
BAU-biofungicide (seed treatment)	45.0	39.3	5.7	32.5	30.4	2.1
BAU–biofungicide (spray)	47.7	41.8	5.9	35.6	32.9	2.7
BAU-biofungicide (seed treatment + spray)	47.7	42.2	5.5	35.7	33.4	2.3
Bavistin (spray)	50.7	45.0	5.7	38.2	35.1	3.1
Control (untreated)	38.0	30.2	7.8	26.1	23.8	2.3
LSD ($P \geq 0.01$)	5.22	3.65	3.02	3.27	3.46	0.69

Data represent the mean of three replications, where 10 plants/replication were counted.

Number of seeds 100-pods^{-1} differed significantly and ranged from 164.7 to 181.7 (Table 3). The highest number of seeds 100-pods^{-1} was recorded from BAU-biofungicide seed treatment + spray followed by BAU-biofungicide spray, spray of Bavistin, leaf extracts of *D. metel* (black) and *A. indica* and the lowest in untreated control. The weight of 100-pods varied from 80.5 to 97.8 g. The maximum weight was recorded from BAU-biofungicide seed treatment + sprays followed by Bavistin and BAU-biofungicide spray. The lowest weight of 100-pods was found under control. Pod yield of groundnut significantly increased over control due to application of all the treatments. The pod yield ranged from 2534 to 3890 kg ha^{-1}. The highest and the lowest pod yields were produced by Bavistin and control, respectively. Under various treatments, dry haulms yield varied from 5.0 to 9.0 t ha^{-1}. The highest and the lowest weights of dry haulms were recorded from Bavistin and control, respectively. The influence of Bavistin, BAU-biofungicide seed treatment + spray, leaf extracts of *A. indica* and BAU-biofungicide seed treatment on dry haulm yield did not differ significantly. The pod yield increase ranged from 10.93-53.51%. The highest pod yield increase was found from the treatment with Bavistin followed by seed treatment + spray with BAU-biofungicide, leaf extract of *A. indica*, BAU-biofungicide spray and *D. metel* (black).

The effectiveness of BAU-biofungicide seed treatment + spray and leaf extracts of *A. indica* was statistically similar but significantly higher as compared to other treatments except Bavistin. The lowest pod yield increase was found under leaf extract of *Polyalthia longifolia* followed by BAU-biofungicide seed treatment, leaf extract of *D. metel* spray, biofungicide spray and *A. indica* spray. These results are supported by those of Adiver (2004), Gopal *et al* (2006), Ihejirika *et al*. (2006) and Stefania *et al*. (2007). Stefania *et al*. (2007) demonstrated that application of *Trichoderma* to the soil as bio-control agent was able to increase yield of groundnut. Adivar (2004) conducting an experiment on botanical preparations against late leaf spot of susceptible groundnut cultivars cv. JL24 noted that the extracts of 10% *Polyalthia longifolia* controlled the disease and increased pod yield over to the control.

Table 3. Effect of three selected botanicals, Bavistin and BAU-biofungicide on number of seeds and weight of 100 pods, pod and haulm yield of groundnut

Treatments	Number of seeds 100 pods^{-1}	Weight of 100 pods (g)	Pod yield (kg ha^{-1})	Haulm yield (t ha^{-1})	(%) pod yield increased over control
Datura metel (spray)	176.7	85.5	3275	6.6	29.24
Azadirachta indica (spray)	176.0	91.4	3528	7.7	39.22
Polyalthia longifolia (spray)	170.0	82.6	2811	7.0	10.93
BAU-biofungicide (seed treatment)	174.5	90.0	3255	7.4	28.45
BAU –biofungicide (spray)	180.0	92.0	3388	6.2	33.70
BAU-biofungicide (seed treatment + spray)	181.7	97.8	3825	8.3	50.95
Bavistin (spray)	177.7	93.2	3890	9.0	53.51
Control (untreated)	164.7	80.5	2534	5.0	-
LSD (*P≥0.01*)	6.20	5.74	3.11	NS	-

Data represent the mean of three replications, where 10 plants/replication were counted.
NS = Not significant

Table 4. Benefit –Cost Ratio (BCR) analysis for five sprays with three different selected botanicals, Bavistin and BAU-biofungicide for controlling leaf spot of groundnut

Functions	*Datura metel* (spray)	*Azadirachta indica* (spray)	*Polyalthia longifolia* (spray)	BAU-biofungicide (seed treatment)	BAU-biofungicide (spray)	BAU-biofungicide (seed treat + spray)	Bavistin (check)	Control (untreated)
Seed (Tk.)	5500.00	5500.00	5500.00	5500.00	5500.00	5500.00	5500.00	5500.00
Preparation of land (Tk.)	6300.00	6300.00	6300.00	6300.00	6300.00	6300.00	6300.00	6300.00
Planting (Tk.)	3200.00	3200.00	3200.00	3200.00	3200.00	3200.00	3200.00	3200.00
Cost of fertilizer and its application (Tk.)	3420.00	3420.00	3420.00	3420.00	3420.00	3420.00	3420.00	3420.00
Weeding (Tk.)	5400.00	5400.00	5400.00	5400.00	5400.00	5400.00	5400.00	5400.00
Cost of treatments (Tk.)	1280.00	2000.00	960.00	50.00	500.00	550.00	2600.00	-
Spraying cost (Tk.)	1200.00	1200.00	1200.00	-	1200.00	1200.00	1200.00	1200.00
Spray of insecticide cost (Tk.)	2025.00	2025.00	2025.00	2025.00	2025.00	2025.00	2025.00	2025.00
Cost of harvesting and carrying (Tk.)	3000.00	3000.00	3000.00	3000.00	3000.00	3000.00	3000.00	3000.00
Cost of processing (Tk.)	3600.00	3600.00	3600.00	3600.00	3600.00	3600.00	3600.00	3600.00
Transportation (Tk.)	1200.00	1200.00	1200.00	1200.00	1200.00	1200.00	1200.00	1200.00
Total cost of cultivation (Tk.)	36125.00	36845.00	35805.00	33995.00	35345.00	35695.00	37445.00	34845.00
Income: Yield (kg/ha)	3275	3528	2811	3255	3388	3825	3890	2534
Sell price (Tk /ha)	131000.00	141120.00	122440.00	130200.00	135520.00	152800.00	155600.00	101520.00
Profit (Tk/ha)	94875.00	104275.00	86635.00	96205.00	100175.00	117105.00	118155.00	66675.00
(%) over control	42.29	56.39	29.94	44.29	50.24	75.64	77.21	-
Cost –Benefit ratio	1:2.63	1:2.86	1:2.42	1:2.83	1:2.83	1:3.28	1:3.16	1:1.91

Legends: Labour cost: Tk.100/labour; Seed cost: Tk. 50/kg; Cost of plouging: Tk.1250/ha (one time); Cost of Bavistin: Tk.1300/kg; Cost of chickpea husk: Tk. 8.0/kg, Cost of neem leaf: Tk. 5.0/kg, Cost of datura leaf: Tk. 4.0/kg; Cost of debdaru leaf: Tk. 6.0/kg, Fertilizer cost : Urea Tk. 10/Kg, TSP: Tk. 20/kg, MoP: Tk.25/kg Zypsum: Tk. 4.0/kg; Boric acid: Tk. 75.0/kg and sold prize of groundnut Tk. 30/kg.

Bdliya and Alkali (2008) reported that the highest seed yield of groundnut (3311 kg/ha) was obtained with neem leaf extract treatment where the lowest seed yield of 2134 kg/ha was from the untreated plot. Similarly, Ashtaputre and Srikant (1999) reported that Neem leaf extract increased seed yield in comparison with the control. The extracts of *A. indica* and *D. metel* increased the pod yield by 15-40% under field conditions was comparable with the commercial fungicide Bavistin (Naudi and Vasanthi, 1995; Ihejirika *et al.*, 2006). Application of 10% *P. longifolia* leaf extract resulted in increased pod yield of groundnut (Adivar, 2004).

The Benefit-Cost Ratio (BCR) of three botanicals, Bavistin and BAU-biofungicide used for controlling leaf spot of groundnut were determined and results are presented in Table 4. The BCR revealed a positive return from the use of materials to control leaf spot of the crop and the profit hectare^{-1}. The yield increase due to the application of Bavistin gave the highest net profit of Tk. 118155 ha^{-1} that was followed by BAU-biofungicide spray + seed treatment Tk. 117105 ha^{-1}, leaf extract of *A. indica* Tk. 104275 ha^{-1}, BAU-biofungicide spray Tk.100175 ha^{-1}, BAU-biofungicide seed treatment Tk. 96205 ha^{-1}, leaf extract of *D. metel* (black) Tk. 94875 ha^{-1} and *P. longifolia* Tk. 86635 ha^{-1}. The return over control ranged from 29.94 to 77.21%. Maximum of 77.21% return over control was obtained from Bavistin, followed by BAU-biofungicide seed treatment + spray (75.64 %), leaf extract of *A. indica* (56.39 %), BAU-biofungicide spray (50.24 %), BAU-biofungicide seed treatment (44.29 %) and leaf extract of *D. metel* (black) (42.29 %). The lowest return over control was obtained from leaf extract of *P. longifolia* (29.94 %). The lowest profit of Tk. 66675 ha^{-1} was obtained from control. Maximum BCR of 1:3.28 was achieved with BAU-biofungicide seed treatment + spray, which was followed by Bavistin (1:3.16), leaf extract of *A. indica* (1:2.86), BAU-biofungicide seed treatment (1:2.83), BAU-biofungicide spray (1:2.83), leaf extract of *D. metel* (black) (1:2.63) and *P. longifolia* (1:2.42). The minimum of 1:1.91 cost –benefit ratio was obtained from control. The results of the present study are supported those of Bdliya and Aikali (2010), Patni *et al.* (2005) and Chandra *et al.* (1998).

Bdliya and Aikali (2010) reported that leaf extract of A. indica gave net profit of $1987.31 per hectare. Patni *et al.* (2005) stated that benefit cost ratio ranged from 2.0 to 6.1. The profit from the sold of haulms which is an additional income to the farmer amounted to $509.45 per hectare following application of leaf extract of *A. indica*. Application of 10% *P. longifolia* leaf extract gave Benefit–Cost Ratio (BCR) of 1:2.60 (Patni *et al.*, 2005). Chandra *et al.* (1998) reported that the Benefit-Cost Ratio using Carbendazim 0.05% + Mancozeb 0.2% treatments (single or combined) ranged from 1:2 to 8:1 in 1993 and 4:1 to 5:5 in 1994.

4. Conclusions

Based on the findings of the present study, it may be concluded that BAU-biofungicide or leaf extract of *A. indica* can successfully be used for eco-friendly management of leaf spot (tikka) disease of groundnut and to obtain higher yield by avoiding fungicidal chemical. However, more research on biological control under different agro-ecological zones of Bangladesh is required for achieving the desired goal.

References

Aage, V. E., Gaikwad, S. J., Behere, G. T. and Tajame, V. S. 2003. Efficacy of extracts of certain indigenous medicinal plant against *Cercospora* leaf spot of groundnut. *Journal Soils and Crops*, 13(1): 140-144.

Abdulrahman, A. and Alkhail, A. 2005. Antifungal activity of some extracts against some plant pathogenic fungi. *Pakistan Journal of Biological Sciences*, 8(3): 413-417.

Adivar, S. S**.** 2004. Field efficacy of botanical preparations on late leaf spot (*C. personata*) of groundnut (*Arachis hypogaea)*. *Oil Seed Research*. 21 (2): 369-370.

Ashtaputre, S. and Kulkarni, S. 1999. Effect of plant extracts and chemicals on late leaf spot of groundnut. *Karnataka Journal of Agricultural Sciences*, 12(1/4): 195-196.

Bakr, M and Ahmed, H. U. 2009. Gradient of oil seed disease management. Advanced in oil seed research in Bangladesh. *Proc. of the Workshop on "Research and development of oil seeds crop in Bangladesh and future challenges"*. 29-30 April, 2009, BARI, Joydebpur, Gazipur. 170 pp.

Bdliya, B. S. and Aikali, G. 2010. Efficacy of some plant extracts in the management of Cercospora leaf spot of groundnut in the Sudan Savanna of Nigeria. *Archives of Phytopathology and Plant Protection*, 43(5): 507-518.

Bdliya, B. S. and Aikali, G. 2010. Cost-benefit of using some plant extracts in controlling Cercospora leaf spot of groundnut in the Sudan savanna of Nigeria. *Archives Phytopathology and Plant Protection*, 43(1): 95-104.

Brenneman, T. B. and Culbreath, A. K. 1999. Peanut disease control. In: *Georgia Pest Control Hand Book*, (ed.) P. Guille beau, The University of Georgia, Special Bulletin 28.

Chandra, S., Kumar, S. and Singh, A. K. 1998. Management of *Cercospora* leaf spot of groundnut (*Arachis hypogaea* L.) with a single fungicidal spray. *International Journal of Pest Management*, 44 (3): 135-137.

Culbreath, A. K., Stevenson, K. L. and Brenneman, T.B. 2002. Management of late leaf spot of peanut with benoyl and chlorothalonil: A study in preserving fungicide utility. *Plant Disease*, 56: 349-355.

DAE, 1985. A Guide Book on Production of Oil Crops in Bangladesh. 1st Ed. Pioneer Printing Press Ltd. Dhaka. 40 p.

Gopal, K., Ahamed, S. K. and Babu, G. P. 2006. Estimation of losses due to tikka leaf spot in groundnut (*Arachis hypogaea* L.). *Legume Research*, 29 (4): 289-291.

Gwary, D. M. and Asala, S.W. 2006. Cost-benefit of fungicidal control of anthracnose on sorghum in northern Nigeria. *International Journal of Agriculture and Biology*, 8 (3): 306–308.

Harman, G. E. 2000. Myths and dogma of bio-control changes in perceptions derived from research on *Trichoderma harzianum* T-22. *Plant Disease*, 84(4): 377-393.

Hossain, M. S., Khalequzzaman, K.M., Hossain, M.A., Hossain, M. and Mollah, M. R. A. 2005. Effect of variety and fungicides in controlling tikka snd rust disease of groundnut. *Journal of Subtropical Agricultural Research and Development*, 3(1): 57-60.

Ihejirika**,** G. O**.**, Nwufo, M. I., Duruigbo, Onwerenadii, C.I., Obili, O. P. Omuoha, E. R. and Ogbede, K. O. 2006. Effect of plant extracts and plant density on the severity of leaf spot disease of groundnut. *Journal of Plant Sciences*, 1 (4): 374-377.

Jackson, C. R. and Bell, D. K. 1969. Diseases of peanut (groundnut) caused by fungi rust *Puccinia arachidis* Speg. *Research Bulletin no. 56.* Georgia Agricultural Experiment Station, Athens, Georgia, USA., 47-51 pp.

Kishore, G. K. and Pande, S. 2005. Integrated management of late leaf spot and rust diseases of groundnut (*Arachis hypogaea*) with *Prosopis juliflora* leaf extract and chlorothalonil. *International Journal of Pest Management*, 51(4): 325-332.

Naidu, P. H. and Vasanthi, R. P. 1995. Influence of sowing dates on late leaf spot in rabi and summer groundnut (*Arachis hypogaea* L). *Legume Research*, 25(4): 275-281.

Natarajan, D., Srinivasan, K., Mohanasundari, C., Perumal, G., Dheen, M.A.N., Ganapathi, G.A. and Rajarajan, T. 2005. Antifungal properties of three medicinal plant extracts against *Cercospora arachidicola*. *Advances in Plant Sciences.* 18 (1): 45-47.

Naznin, H. A. and Hossain, I. 2004. Effect of BAU-Biofungicide on germination and seedling vigour of some summer vegetables. *Bangladesh Journal of Seed Science and Technology*, 8 (2): 85-90.

Pande, S., Rao, J. N., Upadhyaya, H.D. and Lenne, J.M. 2001. Farmers participatory integrated management of foliar diseases of groundnut. *International Journal of Pest Management*, 47(2): 121-126.

Patni, C. S. Kolte, S. J. and Awasthi, R. P. 2005. Efficacy of botanicals against *Alternaria* blight (*Alternaria brassicae*) of mustard. *Indian Phytopathology*, 58(4): 426-430.

Rahman, M. A. and Hossain, I. 1996. Controlling *Cercospora* leaf spot of okra with plant extracts. *Bangladesh Hort.* 24(1&20): 147-149.

Smith, D. H. and Littrell, R. H. 1980. Management of peanut foliar disease with fungicides. *Plant Disease,* 64(4): 356-361.

Stefania, G., Burzi, P. L., Ceratom C., Marinello, S. and Sala. E. 2007. *Trichoderma* as a potential bio-control agent for *Cercospora* leaf spot of sugar beet. *BioControl.* 2008. 53: 917–930.

Subrahmanyam, P., McDould, D., Walliyar, F., Raddy, L.J. and Subba Rao, P.V. 1995. Screening methods and sources of resistance to rust and late leaf spot of groundnut. *Information Bulletin, 47.* ICRISAT. Patencheru, India. 20 pp.

Subrahmanyan, P., Mehan, V. K., Nevill, D. J. and MacDonald, P. 1980. Research on fungal diseases of groundnut (ICRISAT). *Proc. of the International Workshop on Groundnut,* ICRISAT Patancheru A.P. India. 193-198 pp.

Subrahmanyam, P., Williams, J. H. Mcdonald, D. and Gibbons, R.W. 1984. The influence of foliar diseases and their control by selective fungicides on a range of groundnut (*Arachis hypogaea* L.) genotypes. *Annals of Applied Biology,* 104: 467-476.

Wudiri, B. B. and Ftoba, I. O. 1992. Cereals in the food economy of Nigeria. *Proc. of the Workshop on Recent Dev. In Cereal Prod. In Nigeria Kaduna*, 2-4 Sept. 1991. IITA, Ibadan, Nigeria. 13-32 pp.