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GROUNDNUT HAULM QUALITY AS AFFECTED BY CERCOSPORA LEAF SPOT SEVERITY

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Abstract: The effect of cercospora leaf spot caused by *Cercospora arachidicola* i *Phaeoisariopsis personata* on quality of groundnut haulm was assessed using official methods of analysis. The respective field experiments were conducted in 2004 and 2005 cropping seasons, while the laboratory analyses were carried out at the end of the seasons. The scale of 1–9 was used to determine severity of infection on randomly selected groundnut plants. The results showed that the year effect was not significant as related to haulm composition. However, severity of the disease was found to affect haulm composition either negatively or positively. Crude fibre, crude protein, fat and dry matter content of haulm were significantly lower in severely infected haulm samples compared to uninfected or less severely infected samples. While ash, moisture content and nitrogen free extracts (NFE) increased with increasing disease severity. The regression analysis showed that crude fibre, crude protein, fat and dry matter content were negatively related to cercospora leaf spot severity, while ash, moisture content and nitrogen free extracts showed positive relationship with increasing disease severity. Since infection by cercospora leaf spot pathogen lowers the quality of groundnut haulm, controlling the disease is necessary to ensure good quality of haulm at the end of the season.

Key words: groundnut haulm, quality, cercospora leaf spot

INTRODUCTION

Groundnut haulm provides an important animal feed source in the semi arid region of Africa and the Indian continent (Zerbini and Thomas 1999; Njie and Reeds 1995). Though groundnut is grown mostly for its seeds, haulm is also a valuable feed for livestock in the sudano sahelian zone of Nigeria, particularly during the dry season (Njie and Reed 1995; Larbi *et al.* 1999; Etela *et al.* 2000). While the effects of plant diseases on pod and seed yields of groundnut have been extensively studied (McDonald and Fowler 1976; Knauft *et al.* 1988; ICRISAT 1991; Hacina and Kannaiyan

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1990), little was done on the effects of plant diseases on groundnut haulm quality particularly in the sudano sahelian zone of Nigeria where this study was conducted. Damboa local and Ex-Dakar which are the popular groundnut varieties grown in the area of study are highly susceptible to cercospora leaf spot and relatively resistant to rust and rosette. The two leaf spots, early leaf spot caused by *Cercospora arachidicola* and late leaf spot caused by *Phaeoisariopsis personata* cause severe damage to groundnut particularly towards the pod formation stage of the crop leading to lower seed and haulm yields.

In the sudano sahelian zone of Nigeria where animal rearing is a major occupation, groundnut haulm is much valued, even more than the seeds because it is a major source of protein for animal fattening which brings higher income to the farmer than income from selling the seeds. Since diseased haulm are often of a low quality (Pande *et al.* 2003), they have lower prices in the fodder market and this reduces the income from haulm in addition to reduction of seed yield (Rama Devi *et al.* 2000).

Internationally few work has been done on the effect of plant diseases on crop residues (Pande *et al.* 2001, 2003; Bandyopadhyay *et al.* 2001; Rama Devi *et al.* 2000). It is only recently that the effect of plant diseases on crop residues of groundnut and sorghum quality has come to limelight with the work of Pande *et al.* (2003). However, their work was based on the use of fungicides to suppress the disease in the field and did not result in distinct severity levels which are necessary to monitor changes in haulm quality in the aspect of increasing disease severity.

Because of the value of groundnut haulm to the farmers in the sudano sahelian zone of Nigeria, the aim of present study was to investigate the effect of cercospora leaf spot on groundnut haulm quality in this region. Diseased plants were sampled directly from the field. Severity levels were determined and the effect of disease was analyzed in relation to haulm quality composition.

MATERIALS AND METHODS

The field experiments were conducted during the 2004 and 2005 cropping seasons (June–September) on the research field of the Department of Crop Protection, University of Maiduguri (Sudan savanna), Nigeria. The area of approximately three hectares was divided into three equal parts and each part was maintained under either sole groundnut (Ex-Dakar), sorghum (ICSV 400) or millet (SOSAT C-88) for four years before the onset of the experiments. To generate high inoculum in the area cropped with groundnut the crop residues were harrowed into the soil at the beginning of each season. In 2003 the whole area was planted with Ex-Dakar to generate varying levels of cercospora leaf spot incidence and severity. Ex-Dakar is an upright, early maturing, spanish valencia variety, highly susceptible but tolerant to cercospora leaf spot. It is also resistant to rosette and drought tolerant. To increase the inoculum level in the field groundnut residues from the 2003 cropping season were left on the field and harrowed into the soil at the beginning of the 2004 cropping season. This provided a natural inoculum source for the experimental plants.

Ex-Dakar was used as planting material in the two seasons. The experiment consisted of three replicate plots of 300 x 100 m laid out across the area where groundnut, millet and sorghum crops were planted for four seasons. The main purpose of laying out the plots as indicated was to generate differentiated gradients of the disease development from the area previously cropped with different plant species. Two seeds were sown per hole at spacing of 50 x 30 cm on the 8th of July 2004 and on the 4th of July 2005. No specific disease control measures were applied but conventional management practices such as weeding were carried out when required.

Disease incidence was determined by counting the number of plants showing cercospora leaf spot in each of ten quadrants of 5 x 5 m randomly located in the three parts of the plot previously cropped with groundnut, sorghum or millet and expressed as a percentage of the total number of plants in each quadrant. This was done 13 weeks after sowing (WAS) when the pods have reached physiological maturity. Disease index was calculated using the formula:

$$DI = \frac{\text{Number of diseased plants per quadrant}}{\text{Total number of plants in the quadrant}} \times 100$$

The severity scale of 1–9 as described by Subrahmanyam *et al.* (1995) was used where percent of infected leaf area was: 1 = 0%, 2 = 1–5%, 3 = 6–10%, 4 = 11–20%, 5 = 21–30%, 6 = 31–40% and 7 = 41–60%, 8 = 61–80%, 9 = 81–100%. Sampling of haulm for laboratory analyses and the disease severity was also performed at 13 WAS. The disease severity was computed as follows:

$$DS = \frac{\sum n}{N \times 9} \times 100$$

where: DS – cercospora leaf spot severity (%),
$\sum n$ – sum of individual ratings,
N – total number of plants assessed,
9 – highest score on the severity scale.

Samples of the different severity scales were collected randomly across the plots by visual observation following the pictorial score chart described by Subrahmanyam *et al.* (1995). Twenty plants were sampled for each severity scale. Severely infected samples were collected from the area previously cropped with the susceptible groundnut variety for four seasons, while the disease free plants were mostly sampled from the middle or distant borders of the plot previously cropped with millet or sorghum. The samples belonging to the same severity scale from the three replicate plots were pooled together and dried separately under shade. After drying, a sample of 1 kg for each severity scale was taken to the laboratory for analysis.

The laboratory analysis was conducted at the animal nutrition laboratory of the Animal Science Department, University of Maiduguri, Nigeria. The air dried samples were individually ground into fine powder and sieved in 1mm mesh. Triplicate ten gram samples were taken and analysed for crude protein, crude fibre, ash, fat, dry matter content, moisture content and nitrogen free extract (NFE) content following the procedure outlined by Association of Official Analytical Chemist (AOAC 1997). The data obtained were subjected to analyses of variance (ANOVA) and regression.

RESULTS

The incidence and severity of cercospora leaf spot on different parts of the experimental field is shown in Figure 1. Disease incidence and severity were significantly higher on the part of the field where groundnut was successively grown for four years. Low disease incidence and severity were recorded on the areas of the land cropped previously with millet or sorghum. Diseased samples taken from the field for haulm analysis in the two seasons showed that season of sampling did not have much effect on haulm composition as shown in Table 1. The values of different components of the haulm were higher in 2005 than 2004 but most of them did not differ significantly.

However, severe infection by cercospora leaf spot pathogens significantly reduced crude protein and crude fibre content of haulm (Table 1). Most affected was the crude

Table 1. Effect of cercospora leaf spot on groundnut haulm proximate composition

Treatments	Haulm composition [%]						
	crude fibre	crude protein	fat content	dry matter	ash content	moisture content	NFE*
Year (A)							
2004	26.30	9.10	5.17	96.02	10.86	7.57	53.69
2005	27.00	9.78	6.74	96.95	11.01	8.22	54.37
SE±	0.135	0.072	0.144	0.068	0.107	0.028	0.153
Disease severity score (1–9) (B)							
1	28.07 a	14.10 a	7.34 a	97.00 a	10.12 d	7.02 f	49.90 f
2	27.90 a	12.32 b	7.30 a	96.73 a	10.03 d	7.50 e	49.94 f
3	27.80 a	12.30 b	7.28 a	96.32 b	10.31 d	7.60 de	51.91 e
4	26.61 b	11.27 c	7.23 a	96.10 bc	10.40 d	7.60 de	52.63 d
5	26.20 bc	11.02 c	7.10 a	96.00 c	10.45 d	7.63 d	55.07 c
6	25.67 c	1087 cd	6.90 a	96.00 c	11.00 c	7.70 d	55.43 bc
7	25.60 c	10.68 d	6.27 b	95.80 cd	11.01 c	8.01 c	56.00 b
8	25.00 d	9.00 e	6.25 b	95.57 de	12.20 b	8.30 b	57.57 a
9	24.07 e	7.02 f	6.03 b	95.30 e	14.00 a	8.80 a	57.90 a
SE±	0.2859	0.1518	0.3044	0.1434	0.2263	0.0597	0.3249
Interaction							
A x B	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

Column means followed by the same letter(s) are not significantly different at p = 0.05 probability level according to Duncan's Multiple Range Test
*NFE – nitrogen free extracts
n.s. – not significant

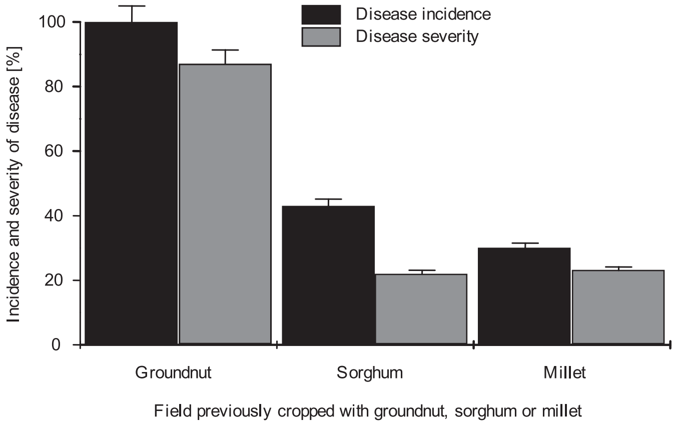

Fig. 1. Incidence and severity of cercospora leaf spot on different parts of the experimental plot previously cropped with groundnut, sorghum or millet for four years. Mean values for two years

protein content. It amounted to 50% reduction in crude protein in the most severely infected samples compared to the uninfected ones. Crude fibre, was significantly reduced as a result of infection by cercospora leaf spot pathogens. However, the reduction was not as marked as in case of crude protein. Dry matter and fat contents were also significantly lower in severely infected samples compared to uninfected ones. In contrast, the ash and moisture contents and nitrogen free extracts were significantly higher in severely infected samples compared to the healthy ones. The interaction of year and disease severity levels was not significant in relation to haulm composition.

The relationship between disease severity and haulm components showed that crude protein, crude fibre, dry matter and fat contents were negatively associated with increasing disease severity, with higher negative relationship in case of crude protein compared to the other haulm components (Figs. 2–5). On the other hand, ash, moisture content and nitrogen free extract were positively associated with increasing disease severity (Figs. 6–8). Figure 2 shows the relationship of crude fibre and disease severity. The regression analysis showed a strong negative relationship between increasing disease severity and crude fibre content of haulm. For every increase in the severity there was a corresponding decrease in crude fibre content. Similarly, Figure 3 shows that increasing disease severity resulted in corresponding marked decrease in crude protein content of haulm. Figures 4 and 5 show the relationship between fat and dry matter contents of the groundnut haulm and cercospora leaf spot severity. The two parameters also had negative relatetionship with increasing cercospora leaf spot severity. Severe infection by cercospora leaf spot pathogens reduced fat and dry matter content of groundnut haulm. In contrast, Figure 6 shows a strong positive relationship between increasing cercospora leaf spot severity and haulm ash content. Similarly, the moisture content and the NFE content of the haulm increased with increasing disease severity (Figs. 7, 8).

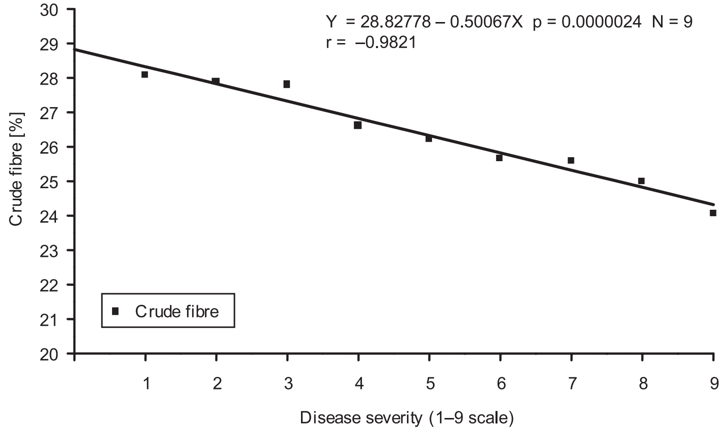

Fig. 2. Relationships between cercospora leaf spot severity and crude fibre content of groundnut haulm in the Sudan savanna of northeastern Nigeria. Mean values for two years

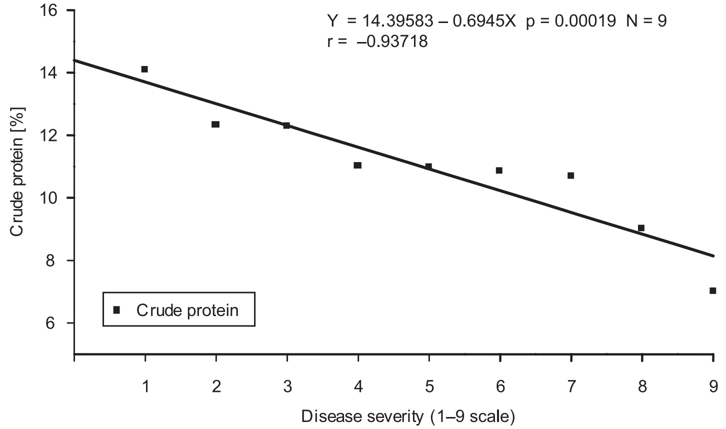

Fig. 3. Relationships between cercospora leaf spot severity and crude protein content of groundnut haulm in the Sudan savanna of northeastern Nigeria. Mean values for two years

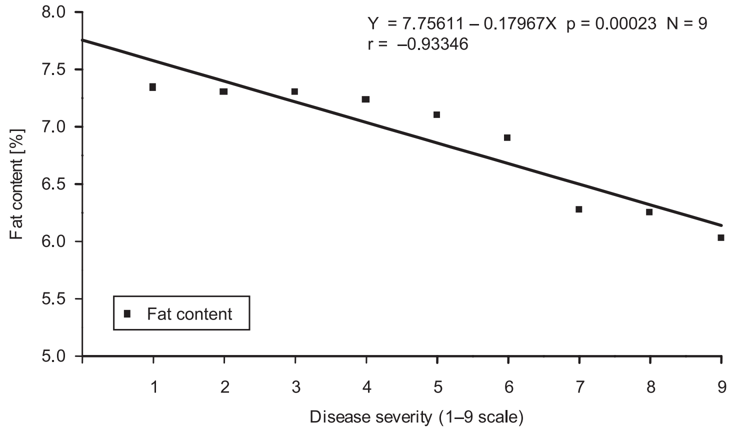

Fig. 4. Relationships between cercospora leaf spot severity and fat content of groundnut haulm in the Sudan savanna of northeastern Nigeria. Mean values for two years

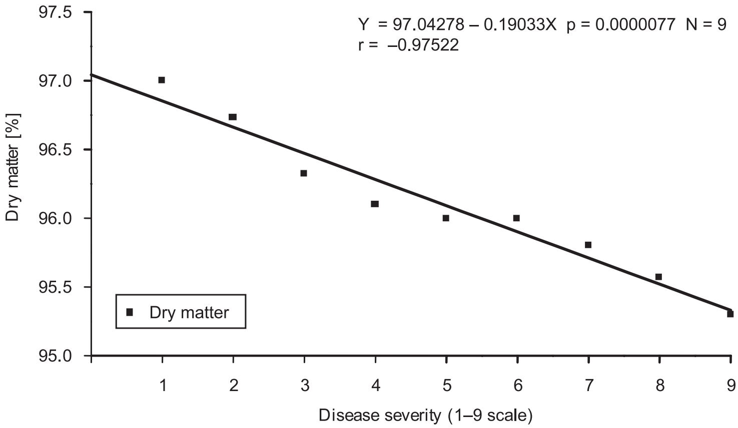

Fig. 5. Relationships between cercospora leaf spot severity and dry matter of groundnut haulm in the Sudan savanna of northeastern Nigeria. Mean values for two years

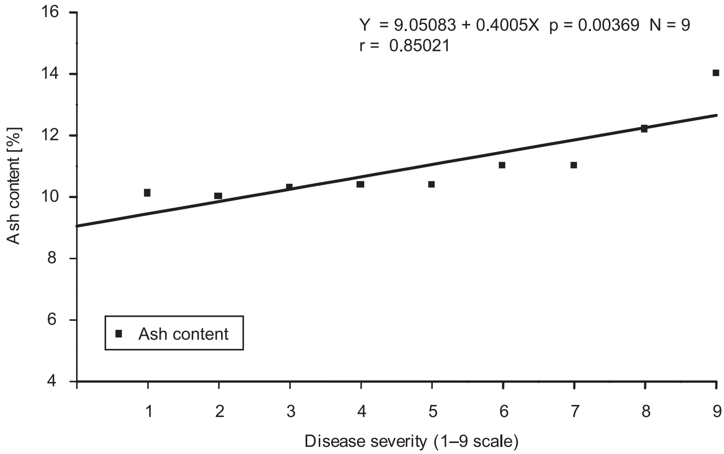

Fig. 6. Relationships between cercospora leaf spot severity and ash content of groundnut haulm in the Sudan savanna of northeastern Nigeria. Mean values for two years

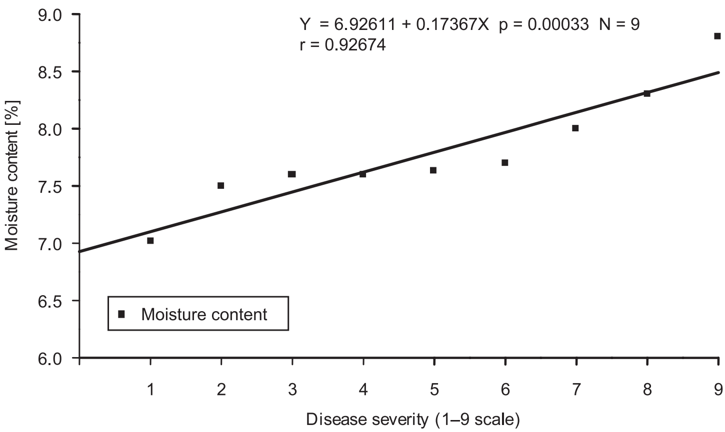

Fig. 7. Relationships between cercospora leaf spot severity and moisture content of groundnut haulm in the Sudan savanna of northeastern Nigeria. Mean values for two years

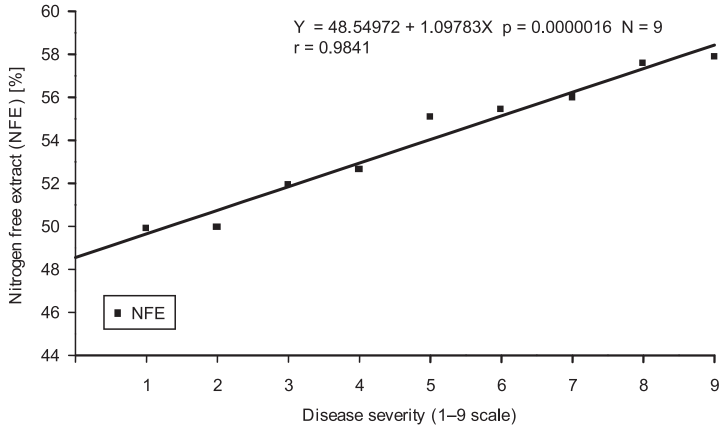

Fig. 8. Relationships between cercospora leaf spot severity and nitrogen free extracts (NFE) of groundnut haulm in the Sudan savanna of northeastern Nigeria. Mean values for two years

DISCUSSION

The rearing of livestock is of great potential importance for people in the semi arid tropics of Africa, but the major constrainst is the availability of good fodder to meet the needs particularly during the long dry season (McIntire *et al.* 1992; Delgabo *et al.* 1999). Crop residues can meet fodder needs in the semi arid regions if properly managed or stored. Of the crops grown in the semi arid regions, groundnut haulm provides the best fodder for livestock. Plant diseases also affect crop residue quality as well as its quantity. Cercospora leaf spots are major diseases of groundnut in the sudano-sahelian of Nigeria. The disease is most severe in areas where groundnut is grown over several years on the same piece of land where severity of the disease can reach a score of 7–9, this being accompanied by marked defoliation towards the end of the season.

In the present study haulm composition values were higher in 2005 than 2004, probably because there was a better crop establishment in 2005 due to higher rainfall in that year. Haulm quality was clearly affected by cercospora leaf spot severity. Foliar diseases like cercospora leaf spot cause defoliation decreasing the leaf-stem ratio. In groundnut, the leaf has more protein and soluble and degradable dry matter (Larbi *et al.* 1999). The low crude protein, crude fibre, dry matter and fat contents recorded in the severely infected samples might be due to damage done to the leaves by cercospora leaf spot pathogens which detroyed almost the entire leaf blades in severely infected samples. Pande *et al.* (2003) reported that high infection of groundnut by late leaf spot pathogens reduced the yield and haulm quality and even *in vitro* digestibility of haulm and leaves. Similar reports on the reduction of protein content of infected leaves were reported by other authors (Moreno *et al.* 1987). They found that comptomeris leaf spot (*Camptomeris leucaenae*) reduced crude protein content by 11 and 18%, respectively, in moderately and severely affected foliage of leucaena. Simiarly, in S*tylosanthes guianensis* plants infected with anthracnose (*C. gleosprioides*) there was 14 and 22% reduction in crude protein in moderately and severely infected foliage, respectively, compared to the healthy controls (Lenne 1986). A marked reduction in crude protein content of the severely infected samples in the presented study confirmed those earlier reports. In other reports, lossess of 17% in digestability, 30% nitrgen content and 42% potassium content were reported in scald (*Monographella albescens*) infected leaves of *Androgan gayanus* (Lenne and Calderon 1989). Results of the present study showed a clear negative relationship between increasing disease severity levels and crude protein, crude fibre, dry matter and fat contents of the haulm (Figs. 2–5). Severely infected haulm with low protein content is not a suitable fodder for animals since ruminants depend largely on plant protein for their growth and development. The crude protein in the severely infected samples is even lower than the minimum required for a normal growth, multiplication and development of the rumen microorganisms that help in the breakdown of crude protein in the rumen of these animals (Kwari and Abator, pers. com). This implies that animals fed on the severely infected groundnut haulm are likely to have reduced feed digestibility due to longer rumen retention time.

Although not as crucial as crude protein, crude fibre generally increases the value of animal feed. However, this depends on the composition of crude fibre. High lignin in the fibre is not desirable because animals cannot digest lignin. Severe cercospora leaf spot infection also reduced the fat content of groundnut haulm. Fat is needed for energy and therefore higher fat content increases the value of haulm. The ash of haulm contains essential minerals like calcium and iron. In the present study ash content was significantly higher in the severely infected samples but the implication for animal nutrition could not be ascertained since the composition of the ash was not determined. Also nitrogen free extracts and moiture content of haulm increased with increasing disease severity. Probably the fungus does not require much of nitrogen free extracts for its growth and development. On the other hand, the destruction of other haulm components by the fungus may lead to the increase in nitrogen free extracts. The reason for the increase in ash, moisture contents and nitrogen free extracts of haulm with increasing disease severity needs further investigation.

CONCLUSIONS

The results of this study clearly showed that severe infection by cercospora leaf spot pathogens significantly reduces crude protein, crude fibre, dry matter and fat content of groundnut haulm lowering its fodder value. Also regression analysis showed a negative association between crude protein, crude fibre, fat and dry matter content and increasing disease severity. To ensure high quality of fodder in the area of performed study where groundnut haulm is a valuable animal feed during the dry season appropriate plant protection measures are necessary. Chemical control or the use of cercospora leaf spot resistant groundnut varieties may reduce damage to groundnut haulm ensuring high quality fodder for animals.

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REFERENCE

AOAC. 1997. Official Methods of Analysis. 16th ed. Association of Official Analytical Chemist (AOAC) Washington D.C., 1018 pp.

Bandyopadhyay R., Pande S., Blummel M., Thomas D., Rama Devi K. 2001. Effect of plant disease on yield and nutritive value of sorghum and groundnut crop residues. In: "Proceedings of the 10th Animal Nutrition Conference". Karnal India, November 9–11, 2001, 28 pp.

Delgado C., Rosegrant M., Steinfeld H., Ehui S., Courbois C. 1999. Livestock to 2020: the next food revolution. Food, Agriculture and the Environment: Discussion Paper No. 28. IFPRI/FAO/ILRI, Washington D.C., 72 pp.

Etela I., Larbi A., Olorunju P.E., Dung D.D., Oji U.I. 2000. Yield and fodder quality of dual-purpose groundnut genotypes fed to West African dwarf sheep. J. Anim. Sci. 84 (Suppl. 1), p. 459.

Hacina C., Kannaiyan J. 1990. Prevalence of groundnut diseases and extent of yield losses due to leaf spot diseases in Zambia. p. 93–97. In: "Proceedings of the Fouth Regional Groundnut Workshop for Southern Africa". Arusha, Tanzania, 10–15 September, 1990.

ICRISAT 1991. International Crops Research Institute for the Semi Arid Tropics, Sahelian Centre, West African Programmes. Annu. Rep., 70 pp.

Knauft D.A., Gorbet D.W., Norden A.J. 1988. Yield and market quality of seven peanut genotypes as affected by leaf spot disease and harvest date. Peanut Sci. 15: 9–13.

Kwari I. D., Abator F. 2007. Personal communication with ruminant animal specialists and lecturers in the Department of Animal Science, University of Maiduguri, Nigeria.

Larbi A., Dung D.D., Olorunju P.E., Smith J.W., Tanko R.J., Muhammad I.R., Adekunle I.O. 1999. Groundnut for food and fodder in crop-livestock systems: forage and seed yields, chemical composition and rumen degradation of leaf and stem fractions of 38 cultivars. Anim. Feed Sci. Technol. 77: 33–47.

Lenne J.M. 1986. Recent advances in the understanding of anthracnose of *Stylosanthes* in tropical America. In: "Proceedings of the XV International Grasslands Congress". Kyoto, Japan, 5–10 August, 1985: 773–775.

Lenne J.M., Calderon M. 1989. Pest and disease problems of a *Andropogon gayanus* Kunth.: A grass for tropical acid soils. CIAT, Cali, Colombia: 247–276.

McDonald D., Fowler A.M. 1976. Control of cercospora leaf spot disease of groundnut (*Arachis hypogaea*) in Nigeria. Niger J. Plant Prot. 2: 43–59.

McIntire J., Bourzat D., Pingali P. 1992. Crop-livestock interaction in Sub-Saharan Africa. The World Bank, Washington, D.C., 125 pp.

Moreno J., Torres G.C., Lenne J.M. 1987. Reconocimiento y evaluacion de enfermedales de leucaena en el Valle de Cauca. Colombia. Pasturas Tropicales 9: 30–35.

Njie M., Reed J.S. 1995. Potential of crop residues and agricultural products for feeding sheep in Gambian village. Anim. Feed Sci. Technol. 52: 312–323.

Pande S., Narayana Rao I., Upadhyaya H.D., Lenne J.M. 2001. Farmers' participatory integrated management of foliar diseases in groundnut. Int. J. Pest Manage. 47: 121–126.

Pande S., Bandyopadhyay R., Blummel M., Narayana Rao J., Thomas D., Navi S.S. 2003. Disease management factors influencing yield and quality of sorghum and groundnut crop residues. Field Crops Res. 84: 89–103.

Rama Devi K., Bandyopadhyay R., Hall A.J., Indra S., Pande S., Jaiswal P. 2000. Farmers' perception of the effects of plant diseases on the yield and nutritive value of crop residues used for peri-urban dairy production on the Deccan Plateau: findings from participatory rural appraisals. International Crops Research Institute for Semi-arid Tropics, Patancheru, Andhra Pradesh, India. Information Bull. 60, 39 pp.

Subrahmanyam P., McDonald D., Walliyar F., Raddy L.J., Nigam S.N., Gibbons R.W., Rammanatha R.V., Singh A.K., Pande S., Reddy P.M., Subba Rao P.V. 1995. Screening methods and sources of resistance to rust and late leaf spot of groundnut. Information Bull. 47. ICRISAT, Patencheru, India, 20 pp.

Zerbini E., Thomas D. 1999. Plant breeding strategies for improving the feed resources for ruminants. p. 189–202. In: "Emerging trends for Livestock and Poultry Feeding Beyond 2000 AD" (K.K. Singhal, S.S. Rai, eds.). Animal Nutrition Society of India and Indian Council of Agricultural Research.

POLISH SUMMARY

JAKOŚĆ NACI ORZECHA ZIEMNEGO W UZALEŻNIENIU OD NASILENIA CERKOSPOROZY LIŚCI

Wpływ cerkosporozy liści wywoływanej przez *Cercospora arachiocola* i *Phaeoisariopsis personata* na jakość naci orzecha ziemnego badano wykorzystując oficjalnie przyjęte metody analizy. Doświadczenia polowe prowadzono w sezonach wegetacyjnych lat 2004 i 2005, natomiast analizy laboratoryjne wykonywano pod koniec sezonów wegetacji. Do określania nasilenia porażenia wykorzystano 9-stopniową skalę.

Skład naci orzecha ziemnego nie był uzależniony od lat badań. Natomiast wykazano, że nasilenie porażenia miało negatywny lub pozytywny wpływ na jej skład. Mianowicie zawartość surowego włóknika, surowego białka, tłuszczu i suchej masy naci były istotnie niższe w próbach silnie porażonych w porównaniu do nieporażonych lub porażonych w niższym stopniu prób. Natomiast zawartość popiołu, wilgoci oraz wyciągów bezazotowych wzrastała wraz ze wzrostem nasilenia porażenia. Również analiza regresji wykazała negatywną zależność pomiędzy zawartością surowego włóknika, surowego białka, tłuszczu i suchej masy nasileniem cerkosporozy liści, natomiast pozytywną zależność stwierdzono pomiędzy wzrostem nasilenia tej choroby a zawartością wilgoci, popiołu i wyciągów bezazotowych.

W związku z negatywnym wpływem cerkosporozy na jakość naci orzecha ziemnego zbieranej w końcu okresu wegetacyjnego konieczne jest chemiczne zwalczanie tej choroby.