JOURNAL OF PLANT PROTECTION RESEARCH
Vol. 47, No. 3 (2007)

COST-BENEFIT OF FUNGICIDAL CONTROL OF CERCOSPORA LEAF SPOT OF GROUNDNUT IN THE SUDAN SAVANNA OF NIGERIA

Bulus Shapshi Bdliya, Kyari Karabi Gwio-Kura*

Department of Crop Protection, University of Maiduguri
P. M. B. 1069, Maiduguri, Borno State, Nigeria

Accepted: September 14, 2007

Abstract: Field trails were conducted to evaluate the economics of controlling cercospora leaf spot of groundnut using different fungicides. The experiments were laid out in a strip plot design with three replications at the Teaching and Research farm of the Department of Crop Protection, University of Maiduguri, sudan savanna of Nigeria during the 2002 and 2003 cropping seasons. Four fungicides namely: Benlate 50 WP, Trimangol 80 WP, Bentex T, and Ridomil 72 WP were applied as foliar sprays at three spray regimes while the control was left untreated. The application of the fungicides led to 20–50% reduction in the disease incidence and 15–22% reduction in disease severity and gave higher yield of seed and haulm than the control. The cost-benefit analysis revealed positive returns per hectare from the use of the fungicides for the control of disease in the study area. Application of Bentex T, for instance, gave 78.13% seed yield increase over the control which translated into a mean (two years) net profit of N52,267.50, N90,905.00 and N138,755.00 Nigerian Naira for one, two and three sprays, respectively, equivalent to $522.675, $909.05 and $1,387.55 per hectare. Even the least effective of the fungicides (Trimangol 80 WP) gave seed yield increase of 62.74% over the control which translated into a mean (two years) net profit of N41,287.50, N68,082.50 and N93,995.00 equivalent to $412.88, $680.83 and $939.95 per hectare for one, two and three sprays, respectively. Three sprays gave 115. 76% increase of yield over one spray and 39.35% yield increase over two sprays. These returns are attractive particularly to the farmers in the study area who grow the high yielding Ex-Dakar groundnut variety which is susceptible to cercospora leaf spot.

Key words: groundnut, cercospora leaf spot, fungicides, control, cost-benefit analysis

*Corresponding author:
bsbdliya@yahoo.com

INTRODUCTION

Cercospora leaf spot of groundnut caused by *Cercospora arachidicola* (early leaf spot) and *Phaeoisariopsis personata* (syn. *Cercospora personata*) (late leaf spot) is the most widespread disease of groundnut in Nigeria. The damages done by the disease generally ranged from defoliation to reduction in pod, seed and haulm yield (Brenneman and Culbreath 2000). Yield losses due to cercospora leaf spot are as high as 50% in the USA (Shokes and Culbreath 1997; Hagan *et al.* 2006) and about 30–40% in Nigeria (Mohammed 2004). Various strategies have been suggested for the control of the disease, however, chemical method still seems to be the most effective way of controlling the disease even in the developed countries like the USA (Smith and Littrell 1980; Culbreath *et al*. 2002; Clark *et al*. 1974). Where resistant varieties of the crop are available they may be the cheapest option. Even though International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) has done a lot of research on the control of cercospora leaf spot of groundnut, chemical method still plays a vital role in their programmes (Pande *et al.* 2003). Though chemicals play a vital role in the control of plant diseases, it is always worthwhile to consider the economics of their use in the light of returns or benefits derivable by the farmers from using such preparations. The use of fungicides for the control of variety of crop diseases is a common practice in the study area and these chemicals are readily available at affordable prices, but how profitable is their use to the farmer is the aspect that has not been given adequate attention. The objective of this study was to evaluate the cost-benefit of four fungicides used for controlling cercospora leaf spot of groundnut in the sudan savanna of Nigeria.

MATERIALS AND METHODS

The experiments were conducted at the Teaching and Research farm of the Department of Crop Protection, Faculty of Agriculture, University of Maiduguri, Nigeria during the 2002 and 2003 cropping seasons. The mean annual rainfall for the two seasons was 494 mm and 653 mm, respectively. The mean minimum and maximum temperatures during the rainy season in 2002 were 24.86°C and 36.34°C, respectively, and for 2003 23.74°C and 34.62°C, respectively.

Ex-Dakar an upright, early maturing spanish valencia variety, tolerant to drought and highly susceptible to both early and late leaf spots was used as planting material. The four fungicides were Benlate 50 WP (1.0 kg a.s./ha), Trimangol 80 WP (2.0 kg a.s./ha), Ridomil 72 WP (1.5 kg a.s./ha) and Bentex T (1.25 kg a.s./ha). A 6 litre Volpi hand sprayer was used to apply the fungicides. The experiments were laid out in a strip plot design with three replications. Each plot measured 3x5 m and one replication consisted of 15 plots. Spacing of 50 cm was maintained between plots and 2 m between replications. Sowing was done on the 16th July in 2002 and 17th July in 2003 when the rainfall was fully established. The seeds were sown at a spacing of 35x25 cm and at a rate of one seed per stand. Recommended cultural practices except for fertilizer application were carried out. No seed dressing chemical was used.

Three spray regimes were evaluated: one, two and three sprays in the season. The sprays were done fortnightly. Control plots remained unsprayed. The occurrence and severity of the disease was assessed as described in the earlier publication (Bdliya and Gwio-Kura 2007). Seed yield was estimated by weighing dried seeds from each net

plot and expressed in kg/ha. The haulm yield was estimated by weighing the dried haulms from each net plot and expressed in kg/ha.

All data obtained were subjected to analysis of variance and the differences between means compared using Duncan's Multiple Range Test. Cost-benefit analysis of using the fungicides to control the disease was carried out at the end of the season taking under consideration all incurred costs (Tables 2–4).

RESULTS

Table 1 shows the incidence and severity of cercospora leaf spot and seed and haulm yield during the two seasons. The incidence of the disease reached 100% in the control in both seasons. The severity of the disease reached 61.4% and 78.9% in the control in 2002 and 2003, respectively, with a mean of 70.1%. The application of four fungicides as foliar spray led to significant reduction in both the incidence and severity of the disease. The incidence of the disease was maintained below 83.7% (combined analysis) with the highest reduction obtained following the application of Bentex T (55.2%). Similarly, the disease severity was maintained below 55.3% with the highest reduction obtained following the application of Bentex T (48.6%) (Table 1). The results also showed improvement in the performance of the crops following the application of fungicides. The highest seed yield of 1979kg/ha (combined analysis) was obtained from crops treated with Bentex T followed by yield in case of Benlate and Trimangol treated crops (1 963 kg/ha and 1 08 kg/ha, respectively). The lowest grain yield of 1 111 kg/ha was recorded from the control. The highest haulm yield of 6 426 kg/ha was obtained from Bentex T treated crops, followed by haulm yield from Benlate and Ridomil treated crops (6 273 kg/ha each) though not significantly different from each other. Three applications of the fungicides in the season gave significant control of the disease compared to once or twice treated crops. Three applications of the fungicides maintained the incidence of the disease below 63.8% (combined analysis) while the incidence of the disease was as high as 96.4% under a single spray regime. Similarly, three sprays with the fungicides maintained the disease severity below 46.9% compared to 66.2% in case of a single spray in the season. Seed yield was almost doubled following three sprays with the fungicides (2 341 kg/ha) compared to one spray in the season (1 085 kg/ha). Similarly, haulm yield was higher following three applications of the fungicides (6 691 kg/ha) compared to one spray (5 341 kg/ha) and two sprays (5 892 kg/ha).

The cost-benefit analysis of using the fungicides for controlling cercospora leaf spot of groundnut is shown in Tables 2–4. The results clearly revealed a positive return per hectare in case of their use to control the disease as indicated by the cost-benefit ratio and the profit or return per hectare. For instance, Bentex T gave about 78.13% increase in yield over the control which was due mainly to the reduction of the disease. This was followed by Benlate with yield increase of 76.69% over the control (Table 1). The yield increase due to the application of Bentex T translated into net profit of N42,810.00 and N61,725.00 per hectare equivalent to $428.10 and $617.25 in 2002 and 2003, respectively, for one spray (Table 2), while for two sprays of the same fungicides it amounted to N76,080.00 and N105,730.00 equivalent to $760.80 and $1,057.30 for 2002 and 2003, respectively (Table 3). For three sprays it translated to N116,885.00 and N160,625.00 equivalent to $1,168.85 and $1,606.25 for 2002 and

Table 1. Effect of fungicides and spray regime on the incidence and severity of cercospora leaf spot, seed and haulm yields of groundnut in 2002 and 2003 seasons at Maiduguri, Sudan savanna

Treatment	Disease incidence [%]			Disease severity [%]			Seed yield [kg/ha]			Haulm yield [kg/ha]		
	2002	2003	combined	2002	2003	combined	2002	2003	combined	2002	2003	combined
A. Fungicides												
Benlate	59.2 bc	70.0 cd	65.3 cd	44.6 c	57.4 c	51.0 c	1697 a	2242 a	1963 a	5974 a	6572 a	6273 ab
Trimangol	68.7 b	87.6 ab	83.7 b	48.2 b	62.4 b	55.3 b	1372 ab	1812 ab	1808 a	5674 a	6379 a	6188 b
Ridomil	64.1 bc	81.4 bc	72.8 bc	45.0 c	64.3 b	55.2 b	1576 a	2075 ab	1587 c	5893 a	6482 a	6273 ab
Bentex T	52.3 c	58.6 d	55.2 d	43.1 c	50.8 d	48.6 c	1716 a	2263 a	1979 a	6131 a	6722 a	6426 a
Control	100.0 a	100.0 a	100 a	61.4 a	78.9 a	70.1 a	962 b	1270 b	1111 d	4752 b	5166 b	4959 c
SE±	6.343	8.423	8.31	1.346	1.520	1.424	91.0	121.0	104.2	96.7	129.9	112.2
B. Spray regime												
Once	87.1 a	97.8 a	96.4 a	57.9 a	74.5 a	66.2 a	939 b	1239 b	1085 c	5088 c	5593 b	5341 c
Twice	78.5 b	89.7 a	80.9 b	52.5 b	68.2 b	60.3 b	1454 a	1920 ab	1680 b	5611 b	6172 b	5892 b
Thrice	56.4 c	71.2 b	63.8 c	41.0 c	52.8 c	46.9 c	2028 a	2672 a	2341 a	6355 a	7027 a	6691 a
SE±	3.1	6.654	4.89	0.725	0.77	0.741	71.1	95.3	81.7	77.68	91.37	82.57
C. Interaction												
A x B	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
n.s. – not significant diference
* p = 0.05

Table 2. Cost-benefit analysis for single spray with fungicides versus control for 2002 and 2003 cropping seasons at Maiduguri

Functions	Benlate		Trimangol		Bentex T		Ridomil		Control	
	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
Land preparation	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Planting	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
Hoe weeding	4000	4300	4000	4300	4000	4300	4000	4300	4000	4300
Fungicides used	2300	2300	2300	2300	2300	2300	2300	2300	–	–
Cost of spraying with fungicides	1500	1600	1500	1600	1500	1600	1500	1600	–	–
Cost of harvesting	2100	2200	2100	2200	2100	2200	2100	2200	2100	2200
Cost of processing	600	600	600	600	600	600	600	600	600	600
Transportation	600	600	600	600	600	600	600	600	600	600
Total cost of production	14500	15000	14500	15000	14500	15000	14500	15000	10700	11100
Income: Yield (kg/ha)	963	1771	933	1232	1347	1995	941	1241	800	1056
Selling price (=N=)	52965	69905	51315	60760	57310	76725	51755	60255	44000	48965
Profit (=N=)	38465	54905	36815	45760	42810	61725	37255	45255	33300	37865
% return over control	15.5	45.0	10.6	20.9	28.6	63.0	11.9	19.5	–	–
Cost-benefit ratio	1:1.4	1:2.0	1:0.9	1:1.0	1:2.5	1:3.8	1:1.0	1:1.6	1:0.8	1:1.3

All costs are in Nigerian naira. Exchange rate in 2002/2003 was about $1.00 to N100.00

Table 3. Cost-benefit analysis for two sprays with fungicides versus control for 2002 and 2003 cropping seasons at Maiduguri

Functions	Benlate		Trimangol		Bentex T		Ridomil		Control	
	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
Land preparation	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Planting	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
Hoe weeding	4000	4300	4000	4300	4000	4300	4000	4300	4000	4300
Fungicides used	4600	4600	4600	4600	4600	4600	4600	4600	–	–
Cost of spraying with fungicides	3000	3200	3000	3200	3000	3200	3000	3200	–	–
Cost of harvesting	2100	2200	2100	2200	2100	2200	2100	2200	2100	2200
Cost of processing	600	600	600	600	600	600	600	600	600	600
Transportation	600	600	600	600	600	600	600	600	600	600
Total cost of production	18300	18900	18300	18900	18300	18900	18300	18900	10700	11100
Income: Yield (kg/ha)	1359	2004	1323	1920	1716	2266	1426	1883	1072	1236
Selling price (=N=)	84745	110220	77765	95600	94380	124630	78430	103565	63460	70980
Profit (=N=)	66445	91320	59465	76700	76080	105730	60130	84665	52760	59880
% return over control	25.9	52.5	12.7	23.3	44.2	76.6	14.0	41.4	–	–
Cost-benefit ratio	1:1.8	1:2.9	1:1.0	1:2.0	1:3.0	1:4.9	1:1.5	1:2.2	1:0.8	1:2.1

All costs are in Nigerian naira. Exchange rate in 2002/2003 was about $1.00 to N100.00

Table 4. Cost-benefit analysis for three sprays with fungicides versus control for 2002 and 2003 cropping seasons at Maiduguri

Functions	Benlate		Trimangol		Bentex T		Ridomil		Control	
	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
Land preparation	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Planting	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
Hoe weeding	4000	4300	4000	4300	4000	4300	4000	4300	4000	4300
Fungicides used	6900	6900	6900	6900	6900	6900	6900	6900	–	–
Cost of spraying with fungicides	4500	4800	4500	4800	4500	4800	4500	4800	–	–
Cost of harvesting	2100	2200	2100	2200	2100	2200	2100	2200	2100	2200
Cost of processing	600	600	600	600	600	600	600	600	600	600
Transportation	600	600	600	600	600	600	600	600	600	600
Total cost of production	22100	22800	22100	22800	22100	22800	22100	22800	10700	11100
Income: Yield (kg/ha)	2463	2672	1992	2406	2527	3335	1805	2383	1155	1285
Selling price (=N=)	135465	146960	109560	123330	138985	183425	110275	131065	64025	71175
Profit (=N=)	113365	124160	87460	100530	116885	160625	88175	108265	53325	60075
% return over control	112.6	106.7	64.0	67.3	119.2	167.4	65.4	80.2	–	–
Cost benefit ratio	1:4.8	1:3.2	1:1.7	1:1.8	1:5.1	1:6.3	1:2.6	1:2.9	1:1.2	1:1.1

All costs are in Nigerian naira. Exchange rate in 2002/2003 was about $1.00 to N100.00

2003, respectively (Table 4). The lowest profit was obtained from the unprotected crops. It amounted to N33,300.00 and N37,865.00 equivalent to $333.00 and $378.65 for single spray in 2002 and 2003, respectively (Table 2). For two sprays it amounted to N52,760.00 and N59,880.00 equivalent to $527.00 and $598.80, in 2002 and 2003, respectively (Table 3), while it amounted to N53,325.00 and N60,075.00 equivalent to $533.25 and $600.75 for three sprays in 2002 and 2003, respectively (Table 4). Similarly, the increase in haulm yield of 29.58% over the control was recorded for Bentex T treated crops and 26.50% for Benlate treated crops. Spraying three times in the season gave 115.76% increase in seed yield over one spray and 78.13% over two sprays in the season. While haulm yield gave 25.28% increase over one spray following three sprays and 13.56% increase in yield over two sprays in the season.

DISCUSSION

The efficacy of Benlate as a fungicide for controlling cercospora leaf spot has been reported by many authors (Porter 1970; Brenneman and Culbreath 2000; Culbreath *et al.* 2002). It was a major fungicide used for controlling cercospora leaf spot in the USA in the seventies and eighties until resistance to the fungicide developed (Clark *et al.* 1974; Littrell 1974; Hagan *et al.* 2006). In the present study, Bentex T seemed to exhibit higher effect on the fungus than Benlate 50 WP, probably due to the additional effects of thiram component. Trimangol 80 WP and Ridomil 72 WP were less effective in controlling the disease.

Previous reports have shown that more than one fungicide spray is needed in a season for effective disease control because the effect of most fungicides does not last more than 2 weeks in the field and hence repeated applications are necessary to provide adequate control of the disease in the season (Hagan *et al.* 2003). The results of our study confirmed these reports. Seed yield was also higher following three sprays compared to one or two sprays confirming earlier reports (Hagan *et al.* 2006).

The cost-benefit analysis revealed positive returns and profit per hectare in case of the fungicides used for controlling cercospora leaf spot on groundnut in the study area. The use of Bentex T gave 78% yield increase over the control giving a mean net profit of N52,267.50, N90,905.00 and N138,755.00 equivalent to $522.68, $909.05 and $1,387.55 for one, two and three sprays of the fungicides, respectively, in the season. Even the less effective chemical (Trimangol) gave a mean net profit of $412.88, $680.83 and $939.95 per hectare for one, two and three sprays, respectively. The returns/ha from this study are encouraging to the farmers in this region since the common groundnut variety grown Ex-Dakar is very susceptible to cercospora leaf spot. Bentex T and Benlate are commonly used by farmers in the study area and are sold at affordable prices. Also, since Ex-Dakar is a short season crop three applications of the fungicides in a season provided adequate control of the disease improving the yield of the crop as shown by the results of this study. Similar studies in the study area have also shown high benefit from the use of fungicides in case of other disease control of major crops grown in this region. Gwary and Asala (2006) reported high net returns from the use of metalaxyl seed treatment followed by foliar spray with benomyl in controlling sorghum anthracnose. The returns obtained in their study translated into a net profit of $136.75 per hectare. In addition to the profit derived from the grain yield, their work has also shown additional income derived from quality of forage.

Similarly, in our study, the protection of foliage by the fungicides resulted in high quality haulm which will also provide additional income to the farmers since the haulm is a valuable animal feed in the sudano-sahelian zone of Nigeria. Similar cost-benefit analysis of fungicidal control of plant diseases in the study area has been reported by other authors (Bwatanglang 2005; Alkali 2005).

The results of this study have clearly demonstrated the benefits derivable from fungicidal control of cercospora leaf spot in the sudan savanna of Nigeria. They have also demonstrated the superiority of Bentex T over the other fungicides in controlling the disease and the benefit of three sprays over one and two sprays in a season. The returns from three sprays with the fungicides particularly Bentex T and Benlate are encouraging to the farmers in this region who cultivate Ex-Dakar groundnut variety.

REFERENCE

Alkali G. 2005. Study on the efficacy of some plant extracts on the management of cercospora leaf spot of groundnut in the Sudan savanna of Nigeria. M. Sc. Thesis. Department of Crop Protection, University of Maiduguri, Nigeria, 112 pp.

Bdliya B.S., Gwio-Kura K.K. 2007. Efficacy of some fungicides in the management of cercospora leaf spot of groundnut in the sudan savanna of Nigeria. J. Plant Protection Res. 47: 243–254.

Brenneman T.B., Culbreath A.K. 2000. Peanut disease control. p. 96–97. In: "2000 Ga. Pest Control Handbook" (P. Guillebeau, ed.). Univ. Ga. Coop. Ext. Serv. Special Bull. 28, 20 pp.

Bwatanglang N. 2005. The effects of fungicides and sowing date in the management of smuts and anthracnose of sorghum in the sudan savanna of Nigeria. M. Sc. Thesis. Department of Crop Protection, University of Maiduguri, Nigeria, 99 pp.

Clark E.M., Backman P.A., Rodriguez-Kabana R. 1974. *Cercospora* and *Cercosporidium* tolerance to Benomyl and related fungicides in Alabama peanut fields. Phytopathology 64: 1476–1477.

Culbreath A.K., Stevenson K.L., Brenneman T.B. 2002. Management of late leaf spot of peanut with benomyl and chlorothalonil: A study in preserving fungicide utility. Plant Dis. 86: 349–355.

Gwary D.M., Asala S.W. 2006. Cost-benefit of fungicidal control of anthracnose on sorghum in northern Nigeria. Int. J. Agri. Biol. 8 (3): 306–308.

Hagan A.K., Campbell H.L., Bowen K.L., Pegues M. 2006. Evaluation of calendar and AU-Pnuts fungicide schedules for the control of late leaf spot and rust on peanut in southern Alabama. Alabama Agric. Exp. Stn. Bull. 663, 15 pp.

Hagan A.K., Campbell H.L., Bowen K.L., Wells L. 2003. Impact of application rate and treatment interval on the efficacy of pyraclostrobin in fungicide programs for the control of early leaf spot and southern stem rot on peanut. Peanut Sci. 30: 27–34.

Littrell R. H. 1974. Tolerance in *Cercospora arachidicola* to benomyl and related fungicides. Phytopathology 64: 1377–1378.

Mohammed Z.H. 2004. Evaluation of groundnut varieties for resistance to cercospora leaf spot in the sudan savanna of Nigeria. M. Sc. Thesis. Department of Crop Protection, University of Maiduguri, Nigeria, 77 pp.

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.

Porter D.M. 1970. Effectiveness of benomyl in controlling Cercospora leaf spot of peanuts. Plant Dis. Rep. 54: 955–958.

Shokes F.M., Culbreath A.K. 1997. Early and late leaf spots. p. 17–20. In: "Compendium of peanut diseases" (N. Kokalis-Burell, D.M. Porter, R. Rodriguez-Kabana, D.H. Smith, P. Subrahmanyam, eds.). 2nd ed. The APS Press, St. Paul, 73 pp.

Smith D.H., Littrell R.H. 1980. Management of peanut foliar diseases with fungicides. Plant Dis. 64: 356–360.

POLISH SUMMARY

OPŁACALNOŚĆ ZWALCZANIA FUNGICYDAMI CERKOSPOROZY LIŚCI ORZECHA ZIEMNEGO W REJONIE SUDAŃSKIEJ SAWANNY NIGERII

Przedstawiono wyniki analizy ekonomicznej opłacalności zwalczania cerkosporozy liści orzecha ziemnego wywołanej przez *Cercospora arachidicola* i *Phaeoisariopsis personata*. Doświadczenia polowe były założone metodą pasów w 3 powtórzeniach, w Dydaktycznej Farmie Doświadczalnej Departamentu Ochrony Roślin Uniwersytetu w Maiduguri sudańskiej sawanny Nigerii, w sezonach wegetacyjnych 2002 i 2003. Do jednorazowego, dwukrotnego lub trzykrotnego opryskiwania roślin użyto następujące fungicydy: Benlate 50 WP, Trimangol 80 WP, Bentex T i Ridomil 72 WP.

Analiza ekonomiczna wykazała wysoką opłacalność zabiegów w porównaniu do nie opryskiwanej kontroli. Zastosowanie fungicydów spowodowało ograniczenie występowania choroby o 20–50%, ograniczenie jej nasilenia o 15–22% oraz przyczyniło się do wzrostu plonu i naci z hektara. W przypadku zastosowania preparatu Bentex T, średni wzrost plonu nasion w 2 latach badań wzrósł w porównaniu do nie traktowanej kontroli o 78,13%, a średni zysk netto z hektara w nigeryjskich nairach (N) wyniósł N52 267,50 ($522 675,00), N90905,00 ($909,05) i N138755,00 ($1 387,55), odpowiednio dla 1, 2 i 3 zabiegów opryskiwania. Nawet najmniej efektywny fungicyd Trimangol 80 WP przyczynił się do wzrostu plonu o 62,74% w porównaniu do kombinacji kontrolnej. Zysk netto z hektara dla 2 lat badań wyniósł N41 287,50 ($412,88), N68 082,50 ($680,83) i N93 955,00 ($939,95), odpowiednio dla 1, 2 i 3 zabiegów. Wyniki te są ważne dla farmerów z rejonu prowadzenia badań, którzy uprawiaja wysoko plonującą lecz wrażliwą na cerkosporozę liści odmianę orzecha ziemnego Ex-Dakar.