NSUK Journal of Science & Technology, Vol. 5, No. 2, ISSN: 1597 - 5527

EFFECTS OF PLASTIC MULCH ON DAMAGE AND YIELD OF YAM TUBER BY YAM BEETLES (*HETEROLIGUS* SPP.) IN DELTA STATE, NIGERIA

TOBIH, F. O.* AND OKONMAH, L. U.

Department of Agronomy, Delta State University, Asaba Campus,
Asaba, Delta State, Nigeria.

***Corresponding author's e-mail: tobih002@yahoo.com**

Article received: 18th May, 2015; Article accepted: 5th July, 2015.

ABSTRACT

The effects of plastic mulch on damage and yield of yam tuber by yam beetles were investigated at two locations in 2005 and 2006 cropping seasons in Delta State. Trials were laid out in Randomized Complete Block Design with three treatments: black plastic mulch, white plastic mulch and as unprotected control plot which were replicated three times. Data collected were, the number, depth and diameter of feeding holes on yam tuber (Dioscorea rotundata cv adaka), tuber yield and percentage yield increase over control as well as percentage tuber attacked and damage scores. The plastic mulch protected plots had positive impact on tuber yields as indicated by the relatively high percentage yield increase over control which ranged from 23%-66%. It was generally observed that plastic mulch protected plots were significantly different (P≤0.05) from the control in all the locations and year of cropping. Investigation revealed that white and black plastic mulches were not very effective against the beetle devastation but offered some protection.

Keywords: Plastic mulch, yam beetle, damage, yields.

INTRODUCTION

The greatest constraint to optimum yam production in Nigeria is largely due to scarcity or high cost of seed yam, labour, insect pests and diseases (Ezeh, 1994; Tobih, *et al*., 2007). Due to wide infestation of yam tuber by yam beetle (*Heteroligus* species) in most of the yam growing areas in Nigeria, the high cost and unfriendly nature of some insecticides to control the beetle menace, the use of other control methods become imperative. In this regard, the use of plastic mulch as a means of controlling yam beetle damage was evaluated.

Mulching is the practice of placing layer of materials either organic or inorganic on the soil surface to reducing the soil temperature and conserve soil water (Simpson, 1987). Mulching is also commonly practiced in gardening. (Whiting, *et al.*, 2005). The practice prevents soil erosion, baking of the soil surface, acts as an insulation and buffer, moderating the effect of weather, soil temperature and activities of the soil biological agents (Onwueme, 1978; Foster, 1984; Ikeorgu and Ezumah, 1991). Utilization of different mulching materials may result in varied influences on crop growth development and yield (Zaragoza, 2002).

Commonly used mulching materials are dry leaves; grass straws, decomposed manures, synthetic mulching materials such as black, white polythene, clear and porous plastics (Mathew and Karikari, 1990. The commonest and most abundant mulch materials available to the small-scale and peasant farmers in the developing countries are the grasses. Organic mulch could be incorporated into the soil after harvesting, thus adding nutrients to the soil for the benefit of the subsequent crops (Acquaach, 2005), generally, mulching increases soil nutrients, moderate soil temperature, conserves soil water, increases water infiltration, suppresses weed which subsequently results in higher crop yields (Kang *et al.,* 1990). Mulching with grass chipping^ was reported to consistently increase the yield of cauliflower and reduced damage by brassica root maggots *Delia* spp. (Hellquist, 1996).). International Institute for Tropical Agric (IITA) introduced the use of plastic mulch as part of the technical package for seed yam production (Otoo *et al.,* 1987). Investigation by IITA Researchers revealed that the yield of seed yam obtained with white polyethylene mulch laid above the black *one* was over 33% higher than when only black polyethylene mulch was used; and 100% increase when compared with unprotected plots in a yam cropping system (IITA, 1986).

Little or no information is available on the use of plastic mulch to control insect pests, though it has been widely used to control weeds in developed countries. Not be practicable in world economic. The objective of this investigation was to assess the influence of different types of plastic mulch on damage and tuber yield by yam beetle in a yam cropping system.

MATERIALS AND METHODS

The investigation was carried out at the Faculty of Agriculture Teaching and Research Farm, Delta State University, Asaba campus and at Ugbolu, a village located in Oshimili North Local Government Area of Delta State in 2005 and 2006. Five-year fallowed sites dominated by *Chromolaena odorata, Ageratum conizoides* and some *Tridax* spp. were chosen for the experiments. The fields at both locations were cleared, demarcated into plots and yam mounds of medium sizes were made with Abakaliki traditional hoe (Ikeorgu and Igwilo, 2002). The gross experimental area was 15m x 12m (180 m^2). There were three treatments plastic mulch, white plastic mulch and the control (no plastic mulch). Nine plots of 4m x 3m with 1m path way were demarcated with the treatments assigned to them in a Randomized Complete Block Design and replicated three times. The mulch materials were obtained from the International Institute for Tropical Agriculture (IITA) Ibadan. Yam setts (*Dioscorea rotundata cv adaka*) weighing 200-250g were planted in mounds spaced 1 x 1 m apart at the rate of one sett per mound on May 22 - 23, in 2005 and May 13 - 15, in 2006. The mulch materials were spread uniformly to cover the entire yam heaps or mounds with small opening of about 2 cm wide at the crest to allow sprouting of the vine as the treatments were applied immediately after planting. The materials were reinforced with ball of soils both at the crest and all round the mounds to prevent exposure and tearing of the materials by winds, rain drops or rodents. After sprouting and vine establishment, staking was done using 2.5 m high Indian bamboo stakes one per mound while the plots were kept weed free manually through hoeing at 3, 8 and 12 weeks after planting. No fertilizer of any kind was applied.

At harvest (December, 20-21 in 2005 and December in 2006), the weight of freshly harvested tubers were recorded and yam beetle damage quantified as the number, depth and diameter of feeding holes per tuber. Percentage tuber attacked, severity of damage and percentage yield increase over the control was computed. Severity damage was based on Agbaje et *al*. (2000) rating where: 1 = no damage; 2 = mild damage; 3 = moderate damage; 4 = severe damage; 5 = very severe damage. Data were subjected to statistical analysis of variance (ANOVA) and significantly different means were separated by Fisher's Least Significant Difference (F-LSD) at 5% probability level.

RESULTS AND DISCUSSION

The results showing the effects of application of plastic mulch on beetle damage and tuber yields are shown on Tables 1 and 2. There were no significant differences in damage indices particularly in depth and diameter of beetle infestation among the treatments. The damage were however apparently higher in the unprotected control plots than the protected ones. Tuber yields were significantly higher in plots with black plastic mulch (17.8 t ha^{-1}) as against 15.66 t ha^{-1} and 10.70 t ha^{-1} recorded for white and unprotected control plots respectively in 2005 at Asaba. Plastic mulch protected plots had varied number of beetle feeding holes which differed significantly in the two years investigations with black mulch showing greater positive influence than the white (Table 1). Beetle feeding hole numbers were however significantly ($P<0.05$) lower in plastic mulch protected plots compared to unprotected plots at both locations in 2005 and 2006. At Asaba, mulched plots had least damage indices compared to the control plots which had significantly severe damage. Results from Ugbolu (Table 2) indicated very negligible damages in all plots protected with plastic mulch while the unprotected plots had significant beetle damages.

The tuber yields in protected plots at Asaba were significantly higher than the control both in 2005 and 2006. The same trend was observed at Ugbolu location (Table 2) except the white plastic mulched plots which had tuber yields significantly ($P< 0.05$) lower than the controls. The apparent higher yields in the plastic mulched plots at both locations may partly be attributed to reduction in beetle damage on the tuber, weed interference, better nutrients conservation and uptake, reduced escape of volatile nutrients and increase in the activities of soil micro and macro-organism (Onwueme, 1978; Ikeorgu and Ezumah, 1991; Hellquist, 1996; Acquaach, 2005). Percentage tuber yield increase over control gave between 46 - 66% and 37- 38% at Asaba in 2005 and 2006, respectively (Table 1). The influence of the plastic mulch on yield was less pronounced at Ugbolu where yield increase of 13% and 21% was recorded in 2005 but was depressed to -23% with black plastic mulch in 2006. The cause of the depression in yield could not be ascertained but may be due to natural phenomenon. Other damage indices evaluated such as percentage tuber attacked and damage scores showed that protected plots suffered less damage than the controls.

The result obtained in the study was consistent with the technical package report by IITA where over 33% tuber yield was obtained using white polyethylene mulch above the black one below which gave about 100% yield higher than the unprotected plots in a yam cropping system (IITA, 1986). In this study, over 66% yield increase in some cases was recorded over the protected control plots.

Table 3 showed the interaction between locations and treatments while Table 4 indicated interaction amongst, locations, treatments and year of cropping. Protected plots had higher tuber yields than the unprotected controls while damage indices like beetle feeding holes, depth, diameter and percentage tuber attacked were more in the controls than mulched plots. The relatively high values of coefficient of variation (cv) recorded for the feeding holes across the locations and cropping periods may be attributed to population density of the beetle which is subjected to natural fluctuation and environmental factors such as temperature, humidity, rainfall etc. This was earlier reported by Amugo and Emosairue (2005), who observed that control of stem borer infestation of upland rice in south-eastern Nigeria fluctuate from year to year. It was further reported that the borer population and their natural infestation was climate dependant.

CONCLUSION

Plastic mulch plots performed generally better than unprotected plots in terms of yam yields and quality. The method is however not only uneconomical but not an effective means of managing yam beetle devastation. More research work is needed in this direction of using plastic mulch to control soil insect pests such as yam beetles**.**

REFERENCES

Acquaach, G. (2005). Principles of Crop Production: Pearson Prentice Hall, New Jersey United State of America.

Agbaje, G. O., Adegbite, A. A., Akinlosotu, T. A. and Soyinka S. A. (2002). Performance of new hybrid yam *(Dioscorea rotundata* Poir) varieties under different cropping system. *African Journal of Root and Tuber Crops* 5(1):8 - 11.

Amugo G. O. and Emosairue, S. O. (2005). The effect of furadan 3 G and Lamdacyhalothrim (Karate 2.5 EC) on the control of stem borer infestation in upland rice in South-eastern Nigeria. *Journal of Sustainable Agriculture and the Environment* 7(2): 146 - 153.

Campligha, E., Tempering, O. and Damato, G. (2000). Effects of soil solarisation on weed control of vegetable crops and on cauliflower and fennel production in the open air. 8thh International symposium on timing of field production in vegetable crops. Bari, Italy Acta Horticulture 533: 249 - 255.

Ezeh, N. O. A. (1994). Economic seed yam production from minisett in Umudike, Southern, Nigeria. Implication for commercial growers. Proc. 8th Triennial symposium of International Society for Tropical Root Crops. Pp.378-381.

Foster, L. (1984). Gardening Techniques. Robert L. Lacopi Publications San Francisco. United State of America p. 15 - 51.

Hellquist, S., (1996). Mulching with grass chipping in cauliflower, effect on yield and brassica root flies *(Delia* spp). International Journal of Pest management. 42 (1): 39 - 46.

IITA (International Institute of Tropical Agriculture), 1986, Annual report and Research Highlights. Ibadan Nigeria. p. 86 - 87.

Table 1: Effect of Plastic on Yam Beetle damage and Tuber Yield at Asaba

Treatments	Tuber Yield (t/ha^{-1})	Mean No. of feeding holes/tuber	Feeding hole (cm) Depth	Feeding hole (cm) Diameter	% Tuber attacked	Damage severity	% Yield increase over control
			2005				
Control	10.70	8.08	1.01	1.38	81.33	4.66	0
Black	17.80	4.21	0.96	1.05	62.33	3.33	66 3
White	15.66	3.54	1.05	1.29	64.33	3.33	46.3
F-LSD (0.05)	0.79	7.59	0.33	0.92	8.87	1.19	
CV (%)	23.77	63.5	14.53	32.74	5.64	13.95	
SE(±)	0.12	11.23	0.02	0.16	15.33	0.27	
			2006				
Control	9.30	8.40	1.19	1.15	78.33	4.00	0
Black	12 80	4.70	0.61	1.15	69.00	3.33	37.60
White	12.90	2.46	0.99	0.91	65.00	3.00	38.70
F-LSD (0.05)	0.64	2.37	0.48	0.58	18.19	1.77	
CV (%)	24.20	20.20	22.79	24.15	11.34	22.69	
SE(±)	0.08	1.09	0.04	0.06	64.44	0.61	

Table 2: Effect of Plastic on Yam Beetle damage and Tuber Yield at Ugbolu

Treatments	Tuber Yield (t/ha^{-1})	Mean No. of feeding holes/tuber	Feeding hole (cm) Depth	Feeding hole (cm) Diameter	% Tuber attacked	Damage severity	% Yield increase over control
			2005				
Control	9.80	7.41	0.98	1.40	83.33	4.66	0
Black	11.9	1.67	0.75	1.16	65.00	3.66	21.4
White	11.1	2.00	0.94	1.11	61.66	3.66	13.3
F-LSD (0.05)	0.16	3.69	2.78	0.66	24.76	2.06	
CV (%)	6.61	44.11	28.44	23.83	15.59	22.82	
SE(±)	0.00	2.65	0.06	0.08	119.16	0.83	
			2006				
Control	9.00	4.70	1.08	1.50	74.00	4.00	0
Black	6.93	2.33	1.01	1,30	66.66	3.66	-23.00
White	10.5	2.16	0.82	1.36	60.33	3.66	19.70
F-LSD (0.05)	0.77	2.28	0.57	0.47	15.48	1.19	
CV (%)	38.92	32.87	26.24	15.17	10.19	13.95	
SE(±)	0.11	1.01	0.06	0.04	46.66	0.27	

Table 3: Interaction between location and treatment on yam beetle damage and tuber yield using plastic mulch as control

Treatments	Tuber Yield (t/ha^{-1})	Mean No. of feeding holes/tuber	Feeding hole (cm) Depth	Diameter	% Tuber attacked	Damage severity
			2005			
Control x location	10.25	7.74	1.00	13.9	83.33	4.66
Black x location	14.88	2.94	0.85	1.08	63.66	3.50
White x location	13.50	2.77	0.99	1.22	63.00	3.50
F-LSD (0.05)	0.30	3.97	0.25	0.46	13.23	0.98
CV (%)	18.30	67.87	21.12	29.48	.14.76	19.73
SE(±)	0.05	9.27	0.04	0.13	105.83	0.58
			2006			
Control x location	9.10	6.55	1.13	1329	76.16	4.00
Black x location	9.88	3.51	0.71	1.10	65.83	3.50
White x location	11.70	2.31	1.00	1.25	64.66	3.33
F-LSD (0.05)	0.39	1.32	0.03	0.28	10.26	0.98
CV (%)	29.81	24.96	24.71	17 79	11 58	21 25
SE(±)	0.09	1.06	0.05	0.04	63.65	0.58

Table 4: Interaction between treatment, location and years on yam beetle damage and tuber yield using plastic mulch as control

Treatments	Tuber Yield (t/ha^{-1})	Mean No. of feeding holes/tuber	Feeding hole (cm) Depth	Diameter	% Tuber attacked	Damage severity
Control x location x year	9.70	7.14	1,06	1.36	79.25	4.33
Black x location x year	12.38	3.22	0.78	1.09	64.75	3.50
White x location x year	12.60	2.54	1.00	1.24	63.83	3.41
F-LSD (0.05)	0.23	1.77	0.18	0.23	7.03	0.57
CV (%)	23.74	49.08	23.58	22.75	12.12	18.36
SE(±)	0.07	4,46	0.05	0.07	70.56	4.47

Ikeorgu, J. E. G. and Ezumah, H. C. (1991). Some analytical aspects of cassava/ maize/ okra/egusi melon complex mixture/ soil temperature in relation to area variation. Field Crops Research 27: 51 - 60.

Ikeorgu, J. E. G. and Igwilo, H. N. (2002). Effect of mulching and staking on yam growth under irrigation during the dry season in Umudike, South Eastern Nigeria. Journal of Sustainable Agriculture and Environment 4 (1): 129 - 132

Kang, B. T., Reynolds, L. and Atta Krah, A. N. (1990). Alley farming (IITA Reprints). In: Advances in Agronomy, Academic Press Inc. San Diego, USA 43: 315 - 359.

Matthew, I. P. and Karikari, S. K.. (1990). Horticulture; Principles and practices Macmillan Press Ltd London.

Onwueme, I. C. (1978). The Tropical Root and Tuber Crops: Yams, Cassava, Sweet Potato and Cocoyams John Wiley and Sons. New York. 234 pp.

Otoo, J. A., Osiru D. S. O., Ngi, S. Y .C. and Hahn, S. K. (1986). Improved technology for seed yam production International Institute of Tropical Agriculture, Ibadan, Nigeria 57 pp.

Simpson, J. G. (1987)._Small gardens, a South Africa guide. C. Struik (Pty) Ltd , Cape Town. p. 1 - 75.

Tobih, F. O. Emosairue, S. O. and L. U. Okonmah (2007). Studies on the occurrence and damage by yam tuber beetles (Heteroligus spp.) in Aniocha and Oshimili areas of Delta State, Nigeria. Journal of Central European Agriculture 8(1): 129 – 134.

Whiting, D., Toian, Meehan, R. B. and Bauer, M. (2005). Colorado State University Extension Horticulture Colorado State University, Colorado. www.ext.colostate edu/pubs/gard.