STUDY OF THE SUITABLE DISTANCE OF VETIVER HEDGES MADE FOR MACADAMIA VARIETIES GROWN ON DIFFERENT SLOPE LANDS BY USING NUCLEAR TECHNIQUES

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Abstract

The research program was established to study the suitable length of vetiver hedge made for macadamia trees grown in mountainous areas (to prevent soil erosion) so that the vetiver roots would not interfere with the fertilizer applied for the trees.

The experiment was conducted at the Doi Tung Development Project, Chiang Rai province, Northern Thailand, during the years 1997-1999. The tracer technique of ^{32}P was used to evaluate root activity of vetiver hedges on the root system of the two macadamia cultivars 246 and 741 at the age of seven years which were grown at high levels (>40-% slope) and low levels (5-10-% slope) of the mountain. Three hedges of the vetiver grass ecotype Surat Thani (*Vetiveria zizanioides* Nash) were made at the distance of 100, 150 and 200 cm from the tree canopy in the shapes of a half circle and a full circle. ^{32}P solution was injected into the soil in the tree canopy area. The measurements of ^{32}P radioactivity were made for vetiver grass which was sampled from different hedges when the vetiver hedges were at the age of 25, 26 and 29 months respectively. No radioactivity of ^{32}P was found in the plant samples. This suggests that the distance of 100 cm from the macadamia canopy is suitable under the studied conditions.

This research project should be continued in order to collect more information for further evaluation to find out the optimum distance of vetiver hedges when the tree becomes more mature.

Introduction

Vetiver *(Vetiveria zizanioides* (L.) Nash), a miracle grass for soil conservation, is widely accepted among agronomists and farmers. There are numerous soil conservation works of vetiver. Vetiver hedges are valuable for erosion control and moisture retention on sloping lands (Intaphan et al. 1997; Rodriguez 1996; Erskine 1992; Greenfield 1990). Vetiver grass was already used by farmers to reinforce rice paddy dikes (Tung and Balina 1993), sweet potato (Yasin et al. 1996), rubber and oil palm plantations on steep slopes in Malaysia (Truong 1993). Pareek et al. (1991) had another type of work by using cowpea grain type Sel-33856, cowpea fodder type NP-3, black gram T-9, green gram PS-16, cluster bean PLG-85, pigeon pea P-33, senna Poona bulk and sacred basil of the eugenol type, as intercrops with vetiver cv Hyb-8 as main crop (spacing 60x25 cm). Each intercrop gave higher profit than control. Highest overall return for the system was obtained with vetiver + cluster bean, followed by vetiver + black gram.

Macadamia plants were grown on steep slopes (40 %) and gentle slopes (5-10 %). The problems of soil erosion, nutrient and water loss were unavoidable. To cope with these, vetiver hedges are a worldwide practice. Thus, the suitable pattern of the vetiver hedges at which macadamia and vetiver roots would not compete with each other should be studied.

Materials and Methods

Field experiments were conducted at different sloping sites (40-% and 5-10-% slopes) within the Doi Tung Development Project area in the years 1997-1999. The soils were Typic Kandihumus, Clayey, Kaolinitic, Hyperthermic and Chiang Khong Variance (Cg).

The vetiver grass ecotype Surat Thani (*Vetiveria zizanioides* Nash) was the testing plant derived from clone propagation through tissue culture technique. The young plants were transplanted from culture for

a three-month survival test. Then they were transplanted to the macadamia field in a split plot design with five replications. The two varieties of macadamia plants involved were No. 246 and 741, both five years old. Two patterns of planting vetiver hedges were adopted. The hedge distances were 100, 150, and 200 cm away from the plant's canopy.

^{32}P Soil Injection: Steep and Gentle Slope

The root distribution technique was used for this study. The researcher had conducted a preliminary test of the pattern of macadamia roots by using nuclear techniques. The ^{32}P solution was injected under the shading of the macadamia tree. Depths of injected holes were 10, 15, 30, and 50 cm respectively. The results are shown in Table 1.

Table 1. ^{32}P content (dpm) in macadamia leaves

Soil depth (cm)	^{32}P content (dpm)
10	350
15	100
30	45
50	42

It was shown that the most active roots appeared at the 10 cm depth, and less activity was observed at the higher depths: 15, 30 and 50 cm respectively.

It could be concluded that the experiment should be done at 10-cm depth under the plant's canopy. A pair of 10-hole sets with spacing 10 cm and 10-cm depth were made to the same horizontal level of vetiver hedges, which were 100 cm apart from the first hedge. The ^{32}P labelled solution as carrier of 1000 mgP/l (KH_2PO_4) (IAEA 1987) had been injected at the activity of 0.13 GBq/hole when the vetiver grass was 12, 16, 25 and 28 months old respectively. The injected holes were completely filled with the soil of that area. The soil surface of the holes was monitored by Geiger Müller (GM) survey meter to ensure that there was no radioactive leaking from the labelled hole. The GM survey meter was used for detecting the activity of ^{32}P on the young vetiver leaves. ^{32}P emitted beta rays and the behaviour in the soil was the same as the ordinary P of fertilizer. The measurement was made after two weeks injection of the ^{32}P labelled solution and then at one-month intervals.

The other technique for measuring the rays of ^{32}P was to take samples from 25- and 28-month-old vetiver tillers from each row at the area of the injected points and to analyse them in the isotope laboratory. The samples were then burned in the electric furnace for five hours at 500°C, and analysed by Cerenkov technique and count with a liquid scintillation counter. The control sample or background (BG) was taken at the proper position far from the injected points. The analysis procedure was the same as that of the labelled samples. The decay correction was used for calculation.

Results

At the age of 12 and 16 months after transplanting of vetiver grass, the results were confusing. There are many natural radioisotopes existing in the vicinity. The needle of the GM survey meter widely swung to the end of the scale with high doses. The measurement of the background was also done with surrounding grass 4 m away from the injected points in order to prove the contaminated rays. The vetiver grass from each row was taken and analysed in the isotope laboratory.^{32}P contents of steep and gentle slopes are shown in Tables 2 and 3.

The vetiver hedges at 25 months of age were selected to check root distribution. Minus value was shown from every hedge (100, 150 and 200 cm away from the plant's canopy) of both varieties of macadamia tree, which meant that no radioisotope was taken up by the grass; this agrees with the

work of Mahisarakul et al. (1996) (Table 8) using ^{32}P, which reported that with *Vetiveria zizanioides* at 10.3 months after transplanting, the distribution of the roots at 30 cm depth in both directions of 90 cm and 60 cm respectively on the left and right sides of the treated grass seemed to be constant. Abdul-

Salam et al. (1993), using the excavation technique to study roots, showed that 88% of the active roots existed at a depth of 40 cm and 92% of the roots was recorded at a horizontal radius of 20 cm. The same technique was done by Yoon et al. (1996) and showed that the massive root system was at the top 0.4-0.5 m. The grass samples were taken at 26 and 29 months respectively to confirm the results of the 25 months old. The results are shown in Tables 4 and 6 for the steep slope area and Tables 5 and 7 for the gentle slope.

This confirmed that there was no radioactive ^{32}P in the vetiver grass at 100, 150 and 200 cm respectively. It could suggest that a vetiver hedge made at a distance of 100 cm from the macadamia canopy offers no competition between vetiver roots and macadamia roots.

Table 2. ^{32}P contents (dpm) in *Vetiveria zizanioides* hedges 25 months old made for macadamia varieties No. 246 and 741 aged 7 years on steep slope land

Type of growing vetiver hedge	^{32} P contents (dpm)					
	Macadamia variety No. 246			Macadamia variety No. 741		
	Row			Row		
	1	2	3	1	2	3
Half circle	-4.14	-5.825	-4.07	-7.6	-6.7	-6.49
Circle	-4.72	-7.43	-9.91	-3.85	-6.7	-8.49

Table 3. ^{32}P contents (dpm) in *Vetiveria zizanioides* hedge 25 months old made for macadamia variety No. 246 and 741 aged 7 years on gentle slope

Type of growing	^{32} P contents (dpm)					
	Macadamia variety No. 246			Macadamia variety No. 741		
	Row			Row		
	1	2	3	1	2	3
Half circle	-6.16	-7.19	-9.84	-10.73	-12.48	-11.98
Circle	-12.43	-4.91	-6.32	-6.94	-8.32	-6.83

Table 4. ^{32}P traces (dpm) in *Vetiveria zizanioides* hedges 24 months old made for macadamia variety No. 246 and 741 aged 7 years on steep slope land

Type of growing	^{32} P contents (dpm)					
	Macadamia variety No. 246			Macadamia variety No. 741		
	Row			Row		
	1	2	3	1	2	3
Half circle	-78.18	-346.25	-67.05	-44.81	-53.43	-57.48
Circle	-45.43	-62.21	-46.18	-100.95	-91.76	-59.83

Table 5. ^{32}P contents (dpm) in *Vetiveria zizanioides* hedge 26 months old made for macadamia variety No. 246 and 741 aged 7 years on gentle slope

Type of growing	^{32} P contents (dpm)					
	Macadamia variety No. 246			Macadamia variety No. 741		
	Row			Row		
	1	2	3	1	2	3
Half circle	-93.16	-87.29	-114.20	-73.65	-62.55	-77.45
Circle	-54.05	-66.14	-69.60	-80.13	-90.18	-92.04

Table 6. ^{32}P contents (dpm) of *Vetiveria zizanioides* hedge 29 months old made for macadamia variety No. 246 and No. 741 aged 7 years on steep slope

Type of growing	^{32} P contents (dpm)	
	Macadamia variety No. 246	Macadamia variety No. 741
	Row	Row

	1	2	3	1	2	3
Half circle	-9.22	-12.36	-9.32	-6.28	-5.84	-6.02
Circle	-9.37	-7.88	-9.78	-13.20	-7.29	-6.50

Table 7. ^{32}P contents (dpm) of *Vetiveria zizanioides* 29 months old made for macadamia variety No. 246 and No. 741 aged 7 years on gentle slope

Type of growing	^{32} P contents (dpm)					
	Macadamia variety No. 246			Macadamia variety No. 741		
	Row			Row		
	1	2	3	1	2	3
Half circle	-9.17	-8.56	-10.32	-10.50	-9.93	-12.38
Circle	-9.12	-11.60	-8.24	-10.07	-6.69	-9.82

Conclusion

The research program was established to study the suitable distance at which vetiver hedges made for macadamia trees grown in mountainous areas to prevent soil erosion do not intercept through their roots the fertilizer applied to the trees. The answer was 100 m. The research project should be continued in order to collect more information for further evaluation to find out the optimum distance for a vetiver hedge when the tree becomes more mature.

References

Abdul-Salam, M.; Shahama, R. S.; Memmen, M. K.; and Kunjamma, P. M. 1993. Rooting pattern of vetiver (*Vetiveria zizanioides* L. Nash) in an Oxisol. Trop. Agric. 70 : 274-275.

Erskine, J. M. 1992. Vetiver grass, its potential use in soil and moisture conservation in southern Africa. South Afr. J. Sci. 80 : 298-299.

Greenfield, J. C. 1990. Vetiver grass: the hedge against erosion. 3rd ed. Washington DC, World Bank.

Intaphan, P.; Boonches, S.; and Vathatum, S. 1997. A test of planting vetiver grass at different vertical intervals for soil and water conservation on slope lands. Vetiver Newsletter 17: 40.

IAEA. 1987. Root activity pattern of some tree crops. Technical reports series No. 170. International Atomic Energy Agency, Vienna.

Mahisarakul, J.; Snitwongse, P.; and Sayamanonta, R. 1996. Root characteristics and root distribution studies on some vetiver grasses using ^{32}P. Proc. ICV-1: 74-85. ORDPB, Bangkok.

Rodriguez, O. S. 1996. Hedgerows and mulch as soil conservation measures on steep lands. Proc. ICV-1: 189-202. ORDPB, Bangkok.

Truong, P. 1993. Report on the international vetiver grass field workshop. Kuala Lumpur. (Soil and water conservation implications for Australia). Australian J. Soil and Water Conserv. 6 (1): 23-26.

Tung, L.; and Balina, F.T. 1993. A methodological account on the introduction of vetiver grass *(Vetiveria zizanioides)* to improve an indigenous technology for soil and water conservation. Contour-Jakarta 5: 1, 4-7.

Yasin, H.G.M.; Nicolas, Y.B.M.; and Djamaluddin, S. 1996. Vetiver grass productivity for soil conservation at sloping areas of Lembah Baliem, Jayawijaya. P2SUT, pp. 57-65.

Yoon, P.K.; Troglia, M.; Tasias, J.V.; Rodriguez, J.N.; and Frutos, D.T. 1996. The introduction, early results and potential uses of VGHR in Mediterranean regions. Proc. ICV-1: 249-255.

Table 8. ^{32}P traces (dpm x 10^3) in *Vetiveria zizanioides* leaves at 10.3 months after transplanting

Depth (cm)	P^{32} traces (dpm x 10^3)																									
	Distance (cm) from the point of P^{32} infection																									
	Left side													Right side												
	140	130	120	110	100	90	80	70	60	50	40	30	20	10	20	30	40	50	60	70	80	90	100	110	120	130	140
30	-	-	-	-	-	15.5	14.5	8.2	12.4	10.8	12.6	14.5	21.0	35.9	15.9	11.3	12.9	10.8	8.7	-	-	-	-	-	-	-	-
60	-	-	-	-	10	8.2	10.3	11.4	8.2	8.7	10.8	10.3	16.3	24.7	16.3	14.2	14.0	10.7	17.7	-	-	-	-	-	-	-	-
90	-	-	-	-	-	-	-	7.2	10.3	10.3	8.9	11.6	11.3	13.7	15.8	10.0	10.3	9.1	-	-	-	-	-	-	-	-	-
120	10.3	15.5	16.6	10.4	52.2	15.5	11.4	16.6	15.5	11.4	9.6	11.9	14.1	33.1	17.1	9.8	10.0	15.5	11.4	15.5	15.5	11.4	-	-	-	-	-
150	-	-	-	-	-	-	-	10.3	11.4	10.3	12.4	11.4	11.7	14.7	12.2	10.5	10.1	9.3	9.3	8.2	7.2	7.2	-	-	-	-	-
180	-	-	-	-	-	-	10.3	7.2	10.3	11.4	7.2	10.3	11.3	12.9	16.6	12.4	12.4	10.3	8.2	11.4	13.4	-	-	-	-	-	-