RESEARCH PAPER International Journal of Agricultural Sciences, June, 2010, Vol. 6 Issue 2 : 395-400

Effect of depth of root pruning and coppicing height of *Gliricidia sepium* on growth, yield and economics of *Rabi* sorghum in alley cropping system

S.Y. WALI*, S.B. DEVARANAVADGI, S.B. PATIL, M.B. JAMBAGI AND D.N. KAMBREKAR

Regional Agricultural Research Station, UAS campus, BIJAPUR (KARNATAKA) INDIA

ABSTRACT

Field experiment was conducted at Regional Agricultural Research Station, UAS Campus, Bijapur on deep black soil to study the effect of depth of root pruning and coppicing height of *Gliricidia sepium* on growth, yield and economics of *Rabi* sorghum in alley cropping system. Among depth of root pruning, pruning at 45 cm depth found beneficial in higher plant height, length and width of earhead of *Rabi* sorghum. The grain and stover yield of *Rabi* sorghum were significantly maximum in 45 cm depth of root pruning (1047.7 and 1677.5 kg ha^{-1}, respectively). Among coppice height, coppicing at 20 cm height noticed higher growth and yield attributes. The significantly maximum grain and stover yield were recorded by 20 cm coppicing height (1019.0 and 1529.5 kg ha^{1}, respectively) and also same treatments were shown higher net returns and B:C ratio. However, none of interaction effect found to significant.

Key words : Agroforestry, Alley cropping system, Coppicing, Economics, Root pruning

INTRODUCTION

Alley cropping is a production system in which trees and shrubs are established in hedge rows on arable crop land with food crops cultivated in the alleys between the hedge row (Kang *et al.,* 1990; Nair *et al.,* 2001). It is one of the most important agroforestry technologies developed in early 1970s at the International Institute of Tropical Agriculture (IITA) Ibadan, Nigeria where the term alley cropping was coined (Harold and Warlito, 1985). The prunings are one of the main benefits provided by hedgerows. Therefore, coppicing must be properly understood and managed to optimize biomass production. Hence coppicing height, alley width and root pruning of hedge row species are important aspects. There are conflicting views regarding coppicing height each depend upon many factors like environmental and edaphic conditions and also the management practices.

In an alley cropping system, there will be always competition for underground and above ground resources between the hedge row species and field crop. It is necessary to minimize the competition by creating niche separation through silvicultural manipulation and use of proper plant ideotypes. The silvicultural manipulation like root pruning of hedge row species will minimize the competition between component species for moisture and nutrients. Further, the above ground competition for right can be manipulated by practicing suitable cutting height/ coppice height of hedge row species. The arable crops grown with hedge row species in an alley cropping model tend to interact with each other. There should be niche separation between the arable species and hedge row species for optimization of yield from the system. To achieve such optimization certain silvicultural manipulation like root pruning and coppicing of hedge row species is essential.This is essential to reduce the competition between component species for light, moisture and nutrient.

According to Korwar and Radder (1994) and Gaddanakeri (1991) root pruning of hedge rows increased the grain and stover yield of alley cropped *Rabi* sorghum compared to unpruned. Therefore, keeping in view of identifying alternative hedge row species to replace leucaena and appropriate *Rabi* sorghum variety compatible to the system were to be worked.Also silvicultural manipulations like root pruning and coppicing for *Gliricidia* which is being accepted as an alternative to leucaena in many other regions are also put for verification. In view of the above facts, the present investigation was carried out to study the effect of depth of root pruning and coppicing height of *Gliricidia sepium* on growth, yield and economics of *Rabi* sorghum in alley cropping system.

MATERIALS AND METHODS

The experiment was conducted at Regional Agricultural Research Station, Bijapur, Farm of University of Agricultural Sciences, Dharwad, Karnataka during *Rabi* season of 2001-02 and 2002-03. The soil of experimental field was medium black soil, having pH 7.9 and EC 0.32 dS m^{1}, 105.0 kg ha^{1} available Nitrogen, 15.2 kg ha^{1} available P_2O_5, 398.0 kg ha^{1} available K_2O and 0.45% organic carbon. The present experiment was

* **Author for correspondence.** & Present Address : Department of Agronomy, College of Agriculture, BIJAPUR (KARNATAKA) INDIA

laid out with Factorial Randomized Block Design (FRBD) with four replications consisted of 12 treatment combinations, comprising three root pruning depths *viz.,* D_1: no root pruning (control), D_2: 30 cm and D_3: 45 cm depth and four coppicing height *viz.,* C_1: 5 cm, C_2: 10 cm, C_3: 15 cm and C_4: 20 cm above ground level of *Gliricidia sepium* hedgerow on the alley cropped *Rabi* sorghum (M 35-1) and it's performance was evaluated during the years 2001-02 and 2002-03. *Rabi* sorghum cultivar 'M 35-1'was sown on 22 September and 7 October with a spacing of 65 cm x 15 cm during 2001 and 2002, respectively. The observations on growth and yield were recorded for two years (2001-02 and 2002-03) using standard techniques and the mean/pooled analysis was taken for interpreting results and data was subjected to statistical analysis (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been presented under following heads:

Growth parameters :

The plant height of sorghum due to depth of root pruning and coppicing height of stem was significantly influenced except at 30 DAS. There was good increase in the plant height from 30 to 60 DAS and 60 to 90 DAS and after that the same had slowed down (Table 1).

At 30 DAS, there was no significant effect of *G. sepium* roots pruning on the plant height of sorghum. However, numerically superior plant height was produced by 45 cm depth (29.32 cm) followed by 30 cm depth (28.16 cm) and the lowest (27.14 cm) were recorded by control (no pruning). Similarly there was no significant effect of *G. sepium* coppice height on the plant height of *Rabi* sorghum. But numerically maximum plant height was recorded in case of 20 cm height of coppicing (29.80 cm) and the minimum was noticed in case of 5 cm height of coppicing (26.36 cm). The interaction effect between the root pruning depth and coppicing height on sorghum plant height was not significant.

At 60 DAS significant differences were noticed in sorghum plant height due to the root pruning depth. The 45 cm depth of root pruning recorded maximum plant height (130.28 cm) and the minimum was noticed in case of no root pruning (93.60 cm). There were significant differences in the sorghum plant height due to the coppice height. The maximum plant height was produced by 20

Table 1 : Plant height (cm) of *Rabi* sorghum at 30, 60 and 90 DAS and at harvest as influenced by root pruning depth and coppice height of *Gliricidia* hedge row

Treatments	30 DAS			60 DAS			90 DAS			At harvest		
	2001-02	2002-03	Pooled	2001-02	2002-03	Pooled	2001-02	2002-03	Pooled	2001-02	2002-03	Pooled
Depth of root pruning (D)												
No root pruning (control)	28.45	25.82	27.14	95.40	91.80	93.60	120.50	115.62	118.06	120.15	114.90	117.53
30 cm. depth	29.67	25.65	28.16	108.15	102.45	103.30	131.38	124.85	128.12	130.10	124.60	127.35
45 cm. depth	31.14	27.30	29.32	134.60	127.75	130.28	155.45	138.75	147.10	152.75	137.90	145.36
S.E ±	1.32	1.26	1.28	4.10	3.75	3.91	5.16	4.85	4.91	5.06	4.52	4.76
C.D. (P=0.05)	NS	NS	NS	11.80	10.92	11.34	15.36	14.64	14.92	14.38	14.14	14.25
Coppice height (C)												
5 cm height	27.12	25.60	26.36	100.55	95.30	97.93	110.60	103.80	107.20	109.85	103.15	106.50
10 cm height	28.75	26.35	27.55	109.30	103.75	106.53	130.15	122.62	126.39	129.90	122.10	126.00
15 cm height	30.40	28.25	29.33	116.45	111.55	114.00	148.25	140.28	144.27	147.65	139.80	143.72
20 cm height	30.75	28.85	29.80	120.20	115.25	117.73	152.10	145.10	148.64	151.80	146.80	149.30
S.E ±	1.54	1.38	1.46	4.57	4.28	4.42	5.87	6.12	5.98	5.85	5.21	5.34
C.D. (P=0.05)	NS	NS	NS	13.49	12.36	12.93	15.12	17.35	16.24	16.90	16.08	16.23
Interaction (D x C)												
S.E ±	2.65	2.51	2.58	8.15	7.35	7.75	10.50	9.80	10.12	109.29	10.05	9.76
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V. (%)	18.70	14.30	16.70	14.5	12.40	13.60	14.1	12.80	12.20	11.8	12.6	12.4

NS = Non significant

cm height of coppicing (117.73) followed by 15 cm height (114.00 cm). Whereas the minimum was recorded in case of 5 cm height of coppicing (97.93 cm). The interaction effect between the root pruning depth and coppicing height of *G. sepium* on sorghum plant height was not significant.

Similar to that of 60 DAS, at 90 DAS also significant differences were noticed in sorghum plant height as influenced by root pruning depth. The maximum plant height was recorded by 45 cm depth of root pruning (147.10 cm) and the minimum was noticed in case of no root pruning (118.06 cm). There were significant differences in the plant height of sorghum as influenced by the coppicing height of *G. sepium*. Coppicing at 20 cm height recorded tallest plants (148.64 cm) followed by 15 cm height (144.27 cm) which were at par with each other and the lowest value was recorded in case of 5 cm coppice height (107.20 cm). The interaction effect due to root pruning depth and coppice height of *G. sepium* was not found significant.

At harvest, the sorghum plant height at harvest in case of different treatments was quite nearer to the values produced at 90 DAS. Significantly taller plants were produced by 45 cm depth of root pruning (145.36 cm) and the minimum value was noticed with no root pruning (117.53 cm). The effect of coppicing height on *Rabi* sorghum plant was found to be significant. The maximum plant height was recorded in case of 20 cm coppice height (149.30 cm) followed by 15 cm (143.72 cm) and the minimum value was recorded with 5 cm coppice height (106.50 cm). The interaction effect of root pruning depth and coppicing height on sorghum plant height was not significant.

The data on number of green leaves per plant of *Rabi* sorghum (Table 2) as affected by depth of root pruning and coppicing height of *G. sepium* did not produce any significant differences. The general trend was found to be increasing upto 90 DAS and there after a reduction was noticed.

At 30 DAS, there were no significant differences due to the depth of root pruning. However, more number of green leaves were produced 45 cm depth of root pruning (6.00) compared to no root pruning (5.20). The number green leaves produced by *Rabi* sorghum did not differ significantly due to coppice height. But numerically more number of green leaves were recorded by 20 cm coppice height (5.73) followed by 15 cm height (5.52) and the minimum value was recorded by 5 cm coppice height (4.70). The interaction effect due to depth of root pruning and coppice height was found to be not significant.

Similar to 30 DAS, at 60 DAS also there were no significant differences as influenced by depth of root pruning. But numerically higher number of leaves were

Table 2 : Number of green leaves at 30, 60 and 90 DAS and at harvest of *Rabi* sorghum plant as influenced by root pruning depth and coppice height of *Gliricidia* hedge row

Treatments	30 DAS			60 DAS			90 DAS			At harvest		
	2001-02	2002-03	Pooled	2001-02	2002-03	Pooled	2001-02	2002-03	Pooled	2001-02	2002-03	Pooled
Depth of root pruning (D)												
No root pruning (control)	5.65	4.75	5.20	9.24	8.15	8.70	8.12	7.25	7.62	5.54	5.10	5.32
30 cm depth	5.80	5.10	5.45	9.35	8.34	8.95	8.38	7.84	8.11	5.65	5.20	5.43
45 cm depth	6.10	5.90	6.00	9.85	8.48	9.17	8.92	8.12	8.52	5.85	5.46	5.66
S.E. ±	0.24	0.21	0.22	0.32	0.37	0.34	0.38	0.31	0.36	0.27	0.21	0.25
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Coppice height (C)												
5 cm height	5.10	4.30	4.70	8.78	7.15	7.93	7.24	6.45	6.85	5.14	4.60	4.87
10 cm height	5.50	4.90	5.20	9.42	8.14	8.78	7.68	6.54	7.11	5.64	5.14	5.39
15 cm height	5.80	5.25	5.52	9.74	8.65	9.20	8.64	7.95	8.30	5.72	5.15	5.44
20 cm height	6.15	5.30	5.73	10.25	9.21	9.73	9.14	8.35	8.75	6.25	5.58	5.92
S.E. ±	0.25	0.29	0.27	0.38	0.46	0.42	0.35	0.28	0.32	0.32	0.26	0.28
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction (D x C)												
S.E. ±	0.42	0.46	0.43	0.63	0.72	0.69	0.65	09.54	0.58	0.48	0.42	0.46
S.E. ±	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.D. (P=0.05)	12.4	16.65	14.30	13.60	15.29	14.46	15.85	14.62	15.23	14.85	16.20	15.74

NS = Non significant

produced by 45 cm depth of root pruning (9.17) compared to no root pruning (8.70). The number of green leaves of *Rabi* sorghum plants produced due to the effect of coppice height did not differ significantly. However, more number of leaves was recorded by 20 cm height of coppicing (9.73) followed by 15 cm height (9.20) and the minimum value was noticed with 5 cm height of coppicing (7.93). The interaction between root pruning depth and coppice height of *G. sepium* were shown not significant.

At 90 DAS, the number of green leaves did not vary significantly due to the depth of root pruning and coppice height. But the number of green leaves produced by 45 cm depth of root pruning (8.52) was superior compared to no root pruning (7.62). The green leaves produced by 20 cm coppicing height (8.75) was highest followed by 15 cm height (8.30) and the lowest was recorded with 5 cm height (6.85). The interaction was found to be not significant.

At harvest, the number of green leaves produced by *Rabi* sorghum plants as influenced by depth of root pruning and coppicing height was not significant. However, maximum value was recorded in case of 45 cm depth of root pruning (5.66) and minimum with no root pruning (5.32). Among coppicing height, higher number of green leaves was recorded with 20 cm height of coppicing (5.92) followed by 15 cm height (5.44) and the lowest value was recorded in case of 5 cm height of coppicing (4.87). None of interactions were shown significant.

Yield parameters :

There was significant difference in the length and width of earhead due to the depth of root pruning and coppicing height (Table 3). Among depth of root pruning, the maximum length and width of earhead were recorded in case of 45 cm depth of root pruning (16.04 and 5.96 cm, respectively) and lowest were produced by no root pruning (12.24 and 4.82 cm, respectively). Among coppicing height, the maximum length and width of earhead were recorded with 20 cm coppicing height (16.68 and 6.09 cm, respectively) followed by 15 cm height (15.64 and 5.78 cm, respectively) which were at par with each other. The minimum value was with 5 cm coppicing height (10.91 and 4.15 cm, respectively). The interaction effect due to different treatment combinations was not significant.

The 1000 grain weight and grain number per plant of *Rabi* sorghum was significantly influenced by different depths of root pruning and copping height (Table 3). It was observed that sorghum with 45 cm depth of root pruning produced highest 1000 grain weight and grain number per plant (37.55 g and 980, respectively) and significantly lowest 1000 grain weight and grain number per plant were recorded by no root pruning (26.10 g and

Table 3 : Length and width of earhead, 1000 grain weight and grain number per plant of *Rabi* sorghum as influenced by root pruning depth and coppice height of *Gliricidia* hedge row

Treatments	Length of ear head (cm)			Width of ear head (cm)			1000 grain weight (g)			Grain number per plant		
	2001-02	2002-03	Pooled	2001-02	2002-03	Pooled	2001-02	2002-03	Pooled	2001-02	2002-03	Pooled
Depth of root pruning (D)												
No root pruning (control)	12.84	11.64	12.24	5.38	4.26	4.82	26.48	25.72	26.10	752	636	694
30 cm depth	14.92	13.60	14.26	5.64	4.36	5.00	30.84	30.12	30.48	845	748	796
45 cm depth	16.70	15.38	16.04	6.21	5.70	5.96	38.56	36.54	37.55	1021	938	980
S.E. ±	0.61	0.52	0.56	0.23	0.21	0.22	1.14	1.04	1.08	34	28	31
C.D. (P=0.05)	1.78	1.54	1.66	0.70	0.58	0.63	3.28	3.02	3.16	98	83	91
Coppice height (C)												
5 cm height	11.57	10.24	10.91	4.54	3.76	4.15	28.12	26.24	27.18	718	669	694
10 cm height	14.94	12.38	13.66	6.28	4.86	5.65	30.85	31.65	31.25	852	762	807
15 cm height	16.52	14.76	15.64	6.44	5.27	5.78	34.26	32.78	33.52	946	795	871
20 cm height	17.92	15.44	16.68	6.54	5.63	6.09	35.69	34.28	34.98	978	856	917
S.E. ±	0.65	0.62	0.64	0.24	0.22	0.23	1.08	0.95	1.02	32	32	34
C.D. (P=0.05)	1.96	1.80	1.87	0.71	0.65	0.68	3.07	2.76	2.92	97	97	105
Interaction (D x C)												
S.E. ±	1.16	1.09	1.12	0.38	0.42	0.40	2.08	1.96	2.03	64	56	60
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V. (%)	14.15	16.36	15.25	13.54	12.16	12.72	14.10	15.65	15.10	15.31	12.87	13.94

NS = Non significant

694, respectively). Among coppicing height, the 1000 grain weight and grain number per plant of *Rabi* sorghum produced significantly highest value in 20 cm coppicing height (34.98 g and 917, respectively) closely followed by 15 cm height (33.52 g and 871, respectively) which were at par and the lowest value was noticed in case of 5 cm coppicing height (27.18 g and 694, respectively). The different treatment combinations did not produce any significant difference.

Grain and stover yield :

The grain and stover yield of *Rabi* sorghum was significantly influenced by the depths of root pruning and coppicing height of *G. sepium* (Table 4). The maximum grain and stover yield was recorded in 45 cm depth of root pruning (1047.7 and 1677.5 kg ha^{-1}, respectively) and minimum was recorded by no root pruning (744.5 and 1125 kg ha^{-1}, respectively). Among the height of coppicing, the highest grain and stover yield was recorded by 20 cm coppicing height (1019.0 and 1529.5 kg ha^{-1}, respectively) followed by 15 cm height (878.0 and 1482.5 kg ha^{-1}, respectively) which were at par with each other. The lowest grain yield was produced by 5 cm coppicing height (739.5 and 1180.5 kg ha^{-1}, respectively). The interaction effect of depth of root pruning and coppice height of *G. sepium* was not found to be significant.

The sorghum crop performed better with treatment having 45 cm depth of root pruning created by trenching. It is mainly due to its superior growth and yield components because of stagnation of water along the bund. Thus in case of 45 cm depth of root pruning there was no moisture stress for crop growth and development throughout the growing season besides it was also important that the effect of lateral roots of *Gliricidia* on the companion sorghum crop was least. The results are in conformity with the findings of Horne *et al.* (1986), Rao *et al.* (1996) and Korwar and Radder (1994).

Economics of system :

The important aspect of decision making to select a system or practice mainly depends on the net returns and benefit cost ratio of system (Table 4).

Maximum net returns and B:C ratio were recorded in *G. sepium* with 45 cm depth of root pruning (Rs. 7,805.25 ha^{-1} and 1.90, respectively) followed by 30 cm depth (Rs. 6,481.50 $ha^{-1}$and 1.68, respectively). Significantly minimum net returns and B:C ratio were recorded by no root pruning (Rs. 5,653.50 ha^{-1} and 1.59, respectively). Among the different heights of coppice significantly maximum net returns and B:C ratio were recorded by 20 cm coppice height (Rs. 7,825.50 ha^{-1} and 2.25, respectively) closely followed by 15 cm height (Rs. 7,767.00 ha^{-1} and 2.23, respectively) which were at par. The lowest value was noticed in 5 cm coppicing height

Table 4 : Grain and stover yield of *Rabi* sorghum and net returns and benefit to cost ratio of *Gliricidia + Rabi* sorghum alley cropping system as influenced by root pruning and coppice height of *Gliricidia* hedge row

Treatments	Grain yield (kg ha^{-1})			Stover yield (kg ha^{-1})			Net returns (Rs/ha)			B:C ratio		
	2001-02	2002-03	Pooled	2001-02	2002-03	Pooled	2001-02	2002-03	Pooled	2001-02	2002-03	Pooled
Depth of root pruning (D)												
No root pruning (control)	806.0	663.2	744.5	1164.0	1086.0	1125.0	6336.70	4974.23	5653.50	1.83	1.34	1.59
30 cm depth	943.5	817.5	881.5	1381.3	1292.0	1336.6	7094.9	5868.15	6481.50	1.90	1.46	1.68
45 cm depth	1108.0	987.5	1047.7	1713.0	1641.0	1677.5	8358.4	7252.10	7805.25	2.10	1.70	1.90
S.E. ±	53.10	48.2	51.2	80.2	71.2	83.2	357.66	576.56	480.50	-	-	-
C.D. (P=0.05)	148.2	132.3	152.4	220.4	210.1	226.3	767.20	1180.76	876.40	-	-	-
Coppice height (C)												
5 cm height	816.0	663.0	739.5	1239.0	1121.5	1180.5	6376.7	5083.28	5730.00	1.90	1.39	1.65
10 cm height	960.0	772.5	866.0	1306.0	1367.0	1367.0	7465.3	6137.20	6801.25	2.22	1.68	1.95
15 cm height	1081.5	887.5	878.0	1542.0	1422.5	1482.5	8488.1	7047.45	7767.00	2.52	1.93	2.23
20 cm height	1122.5	916.0	1019.0	1581.0	1502.5	1529.5	8585.87	7065.13	7825.50	2.55	1.94	2.25
S.E. ±	76.0	54.3	63.6	102.1	104.2	109.4	319.89	383.28	276.71	-	-	-
C.D. (P=0.05)	209.2	150.7	171.4	290.1	301.1	308.0	856.26	822.14	566.69	-	-	-
Interaction (D x C)												
S.E. ±	46.1	32.4	39.6	141.2	134.7	138.6	462.64	712.54	581.28	-	-	-
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	-	-	-
C.V. (%)	14.38	11.63	12.38	14.19	16.48	15.36	18.60	17.50	16.75	-	-	-

NS = Non significant

(Rs. 5,730.00 ha^{-1} and 1.65, respectively). The interaction effect due to treatment combinations was found to be non significant.

REFERENCES

Gaddanakeri, S.A. (1991). Investigations on the effect of leucaena live bund on growth and yield of companion crops under rainfed conditions. Ph.D. Thesis, University of Agricultural Sciences, Dharwad (Karnataka).

Gomez, K.A. and Gomez, A.A. (1984). *Statistical procedure for agricultural research.* John Wiley and Sons, New York. pp. 680.

Harold, R.W. and Warlito, A.L. (1985). Sloping agricultural land technology. A social forestry model in the Philippines. In: *Community forestry – Lessons from Case Studies in Asia and Pacific Regions*. FAO, Bangkok, pp. 87.

Horne, D.W., Chatchpool, D.W. and Ella, A. (1986). Cutting management of tree and shrub legumes. Proceedings of International Workshop on Agroforestry held at Cisarwa, Indonesia. 19-23 August 1985. ACIAR-Proceedings No. 12: pp 164-169.

Kang, B.T., Reynolds, L. and Atta-Krah (1990). Alley farming. *Adv. Agron.,* **43** : 315-359.

Korawar, G.R. and Radder, G. D. (1994). Influence of root pruning and cutting interval of leucaena hedgerows on performance of alley cropped *Rabi* sorghum. *Agroforestry Systems,* **25** : 95-109.

Nair, P.K.R., Kass, D. L. and Kay, B.T. (2001). Nutrient cycling and soil erosion control in agroforestry system. pp 117-138. In A.S.R. Juo and R.D. Freed (ed) *Agriculture and Environment* : Bridging food production and environmental protection in developing countries. ASA Spec. Publ. 60. ASA, Modison, WI.

Rao, Muthiah Govindarajan, M.R., Moises, N.M. and Nair, P.K.R. (1996). Soil water and root dynamics under hedgerow intercropping in semi arid Kenya. *Agron. J.,* **88**: 513-520.

Received : October, 2009; Accepted : February, 2010