Short communication

Allelopathic effect of leaf loppings of homestead trees on ginger (*Zingiber officinale* Roscoe)

Eldhose Abraham*[1], Jacob John[2] and P. Shalini Pillai[1]

[1]*College of Agriculture, Kerala Agricultural University, Vellayani, Thiruvananthapuram,* [2]*Cropping Systems Research Centre, Karamana, Kerala Agricultural University, Trivandrum 695 011, India.*

Received 14 July 2016; received in revised form 22 July 2016; accepted 28 July 2016

Abstract

A pot culture study was carried out to investigate the allelopathic effect of mulching with fresh leaves of eight tree species *viz.,* jack (*Artocarpus heterophyllus* Lamk.), mango (*Mangifera indica* L.), tamarind (*Tamarindus indica* L.), *matty* (*Ailanthus triphysa* Dennst.), wild jack (*Artocarpus hirsuta* Lamk.), teak (*Tectona grandis* L.f.), rubber (*Hevea brasiliensis* Mull. Arg.) and *panal* (*Glycosmis pentaphyllus* Retz.) on growth and yield of ginger (*cv.* Karthika). Mulching with mango and tamarind leaves adversely affected growth and yield of ginger. Rhizome yield was significantly less when mulched with mango (521 g plant^{-1}) and tamarind (512 g plant^{-1}) leaves which was a consequence of the significantly lower plant growth, tiller production, leaf production, root length, root spread, rhizome spread, rhizome thickness and stomatal conductance in ginger. However, mulching with all the other tree leaves gave significantly high rhizome yield. An interesting observation was that in the control where newspaper was used as mulch, the yield was high (637 g plant^{-1}) and comparable to mulching with *panal*, rubber, teak, *matty*, wild jack and jack leaves.

Key words: Allelopathy, Ginger, Homestead, Leaf loppings, Mulch, Trees

Ginger (*Zingiber officinale* Roscoe), a commercial crop of great importance in the tropics and subtropics, is extensively cultivated in Kerala. Ginger is a shade tolerant crop and is hence, suitable for intercropping under the shaded conditions existing in multistorey home gardens of Kerala. Mulching ginger subsequent to planting with green leaves at the rate of 15 t ha^{-1} and twice thereafter at 44-60 days and 90-120 days @ 7.5 t ha^{-1} is also recommended (KAU, 2011). Information on the allelopathic effect of tree leaves when used as mulch and the compatibility of trees beneath which ginger is planted is lacking. Trees produce a substantial quantum of litter which is a potential source of allelochemicals. The allelochemicals released are primarily secondary metabolites, which are evolved as by-products during various physiological processes in plants (Bhadoria, 2011). Researchers have not paid much attention to allelopathic properties of agroforestry species. Such information is needed to identify the compatible tree-crop combinations. Hence, the present investigation was taken up with the objective of investigating the allelopathic effect of leaf loppings of trees commonly planted in the homesteads of southern Kerala when used as mulch, on sprouting, growth and yield of ginger.

A pot culture experiment was conducted in the Instructional farm, College of Agriculture, Vellayani, Thiruvananthapuram during the period from February to December 2015. The experiment was laid out in completely randomized design and comprised of nine treatments viz. M_1 (mulching with

*Author for correspondences: Phone- 91-8547056109, Email: eldhoseabraham10@gmail.com

fresh leaf loppings of jack), M_2 (mango), M_3 (tamarind), M_4 (*matty*), M_5 (wild jack), M_6 (teak), M_7 (rubber), M_8 (*panal*), M_9 (control with newspaper). All treatments were replicated thrice and each replication consisted of four grow bags. The ginger variety Karthika was used for the study. The study was conducted using UV (ultra violet) stabilized grow bags of 25 cm height and 30 cm diameter, capable of holding 15 kg of growing media. The grow bags were filled with potting mixture containing sand, soil and cow dung in the ratio 1:1:1 which was exposed to sunlight for one week to eliminate the presence of any allelochemicals. Organic manure and nutrients (N: P_2O_5: K_2O) were applied as per the Package of Practices Recommendations for Kerala (KAU, 2011). Healthy ginger rhizomes of uniform growth (at 2 leaf stage) were planted in the grow bags. Fresh leaf loppings of the test trees were applied as mulch @ 15 Mg ha^{-1} immediately after planting. Mulching with green leaves @ 7.5 Mg ha^{-1} was repeated twice, first at 55 days and second at 110 days after planting (KAU, 2011). The equivalent quantity of tree leaf loppings applied in a single grow bag used for the study was 100 g as basal and subsequently with 50 g each at 55 days and 110 days after planting. A control was also maintained and mulching was done with equivalent quantity of newspaper. All the grow bags were irrigated with uniform quantity of water, as and when needed.

Biometric observations were recorded at bimonthly intervals from 2 months after planting (MAP). Plant height was measured from the base of the pseudostem to the tip of the topmost leaf. The number of tillers per plant was recorded by counting the number of aerial shoots arising around each plant. Number of leaves produced was recorded by counting the number of leaves on the tillers of each plant. The horizontal spread of rhizome was measured at the time of harvest. The diameter of the rhizome was measured by using a thread through the central portion. The root length was recorded at the time of harvest by measuring the greatest length of roots. Root spread was measured at the time of harvest by spreading the root system on a marked paper and measuring the spread of the root system at its broadest part. Roots alone were separated from individual plants at the time of harvest and dried in hot air oven at 70-80^{0}C. Root volume per plant was determined at the time of harvest by displacement method. Canopy temperature and stomatal conductance was measured at 5 MAP (active growth stage) using steady state porometer (Spectro Analytical). SPAD value was recorded at 5 MAP using chlorophyll meter (Konica Minolta Model SPAD 502). The yield of fresh rhizome from each treatment was recorded at harvest. The yield of above ground portion (pseudostem, leaves and inflorescence) was recorded from the individual treatments at harvest. From each treatment, 100 g of fresh rhizomes were taken and dried in a hot air oven at 70-80^{o}C. The weight was then expressed as recovery percentage. The data generated from the experiment were statistically analysed using Analysis of Variance technique for completely randomized design (Panse and Sukhatme, 1985).
At 2 MAP, when compared to control (mulched with newspaper), height was least in plants mulched with mango and tamarind. At 4 MAP, least plant height was recorded in plants treated with mango, wild jack, *matty* and tamarind leaves. But, plant height was significantly greater when treated with *panal* leaves and was on par with control (Table 1).

At 2 MAP, highest number of tillers was produced when mulched with *panal* leaf loppings and was on par with control. When compared to control, tiller production was significantly less when mulched with mango and *matty* leaves. At 4 MAP, number of tillers was less when mulched with mango, *matty* and jack. But, effect of mulching *panal* and rubber leaves was on par with control. A similar trend was noticed at 6 MAP.

The effect of the tree leaves on leaf production showed a similar trend at 2, 4, and 6 MAP. Leaf production was highest when mulched with *panal* leaves and was on par with the control, while it was least when mulched with mango and jack.

Table 1. Effect of tree leaf loppings on plant height, number of tillers and number of leaves of ginger

Treatment	Plant height (cm)			Number of tillers			Number of leaves		
	2MAP	4MAP	6MAP	2MAP	4MAP	6MAP	2MAP	4MAP	6MAP
M_1 Jack	38.65	53.73	87.38	3.41	9.56	13.54	6.87	10.67	135.72
M_2 Mango	36.84	46.67	80.49	3.04	8.46	11.31	6.97	11.20	140.35
M_3 Tamarind	34.89	50.83	82.68	3.66	12.40	14.77	7.97	13.07	177.20
M_4 Matty	39.53	49.42	91.92	3.32	9.14	12.76	7.63	11.87	162.49
M_5 Wild Jack	38.43	48.42	91.70	3.66	10.19	15.45	7.87	14.23	180.62
M_6 Teak	38.17	55.91	85.73	3.67	10.66	13.57	7.50	12.67	149.23
M_7 Rubber	40.14	56.44	91.92	4.01	13.54	16.42	8.53	14.43	169.90
M_8 Panal	46.50	64.65	94.36	4.45	15.33	17.49	12.00	18.07	192.43
M_9 Control	43.16	58.76	93.41	4.13	14.66	16.92	10.00	17.63	186.09
SEm (±)	1.85	2.56	4.19	0.26	0.89	1.12	0.46	0.70	7.64
CD (0.05)	5.511	7.602	NS	0.802	2.653	3.339	1.374	2.091	22.729

MAP-Months After Planting

Table 2. Effect of tree leaf loppings on rhizome and root characteristics of ginger

Treatment	Rhizome spread (cm)	Rhizome thickness (cm)	Root length(cm)	Root spread(cm)	Root weight per plant (g)	Root volume per plant (cm^3)
M_1 Jack	22.07	1.72	40.52	20.13	8.75	17.30
M_2 Mango	17.97	1.73	31.52	19.34	9.00	16.09
M_3 Tamarind	17.37	1.56	35.85	19.42	7.79	16.03
M_4 Matty	25.67	1.80	45.18	22.47	12.75	25.15
M_5 Wild Jack	24.63	1.78	41.18	26.32	11.50	22.71
M_6 Teak	25.67	1.75	40.85	20.72	9.50	18.76
M_7 Rubber	26.23	1.92	47.18	27.14	9.13	17.76
M_8 Panal	28.80	2.03	53.52	28.45	10.38	20.46
M_9 Control	28.16	1.98	47.52	27.42	13.13	25.88
SEm (±)	0.72	0.07	2.47	1.33	0.75	1.39
CD (0.05)	2.159	0.229	7.360	3.950	2.232	4.143

Rhizome spread was significantly greater in plants mulched with *panal* leaves and was on par with control. Rhizome spread in plants mulched with leaves of mango and tamarind was significantly less than all the other treatments. Plants mulched with *panal* and rubber leaves had considerably greater rhizome thickness and was on par with control. Rhizome thickness was substantially less when mulched with tamarind, jack and mango leaves (Table 2).

Root length was significantly greater when mulched with *panal* and rubber leaves and was on par with the control. A similar trend was observed with respect to root spread. However, root weight and root volume were significantly greater under *matty*, wild jack and control. Root length, root spread, root weight and root volume were conspicuously less when mulched with mango and tamarind leaves.

Among the physiological parameters, stomatal conductance alone was affected and it was significantly more in plants mulched with *panal* leaves. However, in plants mulched with tamarind, jack, mango and teak it was markedly less (Table 3).

Rhizome yield was significantly less when mulched with mango (521 g $plant^{-1}$) and tamarind (512 g $plant^{-1}$) leaves. However, mulching with all the other tree leaves and the control (newspaper) gave appreciably higher rhizome yield (Table 4). Top

Table 3. Effect of tree leaf loppings on physiological parameters of ginger

Treatment	SPAD reading	Canopytemperature (^{0}C)	Stomatal conductance(millimol m^{-2} s^{-1})
M_1 Jack	41.58	30.67	72.56
M_2 Mango	40.27	30.11	78.23
M_3 Tamarind	44.63	30.14	68.46
M_4 Matty	42.20	30.41	75.49
M_5 Wild Jack	41.60	30.44	83.17
M_6 Teak	42.38	30.47	79.61
M_7 Rubber	38.72	30.28	92.46
M_8 Panal	43.64	30.90	112.85
M_9 Control	46.20	30.94	93.57
SEm (±)	1.94	1.43	4.03
CD (0.05)	NS	NS	11.988

NS- Non Significant

Table 4. Effect of tree leaf loppings on rhizome yield, top yield and dry ginger

Treatment	Rhizome yieldper plant (g)	Top yieldper plant (g)	Dry ginger(recovery %)
M_1 Jack	601.11	29.24	20.02
M_2 Mango	521.19	20.04	20.34
M_3 Tamarind	512.09	19.38	19.73
M_4 Matty	613.60	32.64	21.16
M_5 Wild Jack	607.11	32.52	21.35
M_6 Teak	617.32	28.47	21.75
M_7 Rubber	621.40	36.64	20.56
M_8 Panal	653.50	32.70	20.48
M_9 Control	637.01	33.12	21.02
SEm (±)	20.81	1.36	0.98
CD (0.05)	61.854	4.060	NS

yield of ginger was highest when mulched with rubber and *panal* leaves and least with tamarind and mango.

It is clearly evident that mulching with mango and tamarind leaves had an adverse effect on growth and yield of ginger. This was a consequence of the significantly lesser plant growth, tiller production, leaf production, root length, root spread, rhizome spread, rhizome thickness and stomatal conductance in ginger when mulched with tamarind and mango leaves. This is corroborated by the findings of Sahoo et al. (2010) who reported that water soluble leachate from the mature fresh leaves of mango had the allelopathic potential to reduce the germination as well to suppress the growth and development of the crops. They recorded that the root lengths were more sensitive to allelochemicals than the shoot length, ultimately affecting the biomass. Yield reduction in cowpea by tamarind leaf loppings has also been reported (KAU, 2009). Though plant height was less at 4 MAP when mulched with leaves of wild jack and *matty*, this was not reflected in any of the other growth and yield attributes.

The estimations made in the present study revealed that fresh leaf extracts of mango and tamarind contained high phenol. This might have been released into the soil during the process of decomposition. Mango leaves were reported to contain 43 to 46 per cent euxanthin acid ($C_{19}H_{16}O_{10}$) and also some euxanthon ($C_{13}H_8O_4$), hippuric acid and benzoic acids and four per cent mangin (Bhatt and Todaria, 1990). An analysis revealed that caffeic acid, ferulic acid, coumaric acid, benzoic acid, vanillic, chlorogenic, gallic, hydroxybenzoic and cinnamic acid were present in mango leaf extract (El-Rokiek et al., 2010). These chemicals

too might have had a role in the observed effect of mango leaves. In tamarind, chemicals like alpha terpineol, cinnamaldehyde, ethyl cinnamate, galacturonic acid, geranial essential oil, geraniol essential oil, limonene, linoleic acid, myristic acid, oleic acid, palmitic acid, pantothenic acid, phenol, pipecolinic acid, tannin and tartaric acid have been identified (Duke, 1992).

Better growth, yield attributes and higher ginger yield were recorded when mulched with *panal* and rubber leaves. The yield obtained by mulching with leaves of teak, *matty*, wild jack and jack also resulted in comparable high yield. Some of the main groups of compounds identified from *panal* included terpenoids, amides, imides, alkaloids, coumarins and flavonoids (Sreejith et al., 2012). These groups may comprise many phytochemicals some of which may be stimulatory and responsible for the positive effects on the crop. Some of the alkaloids reported from the leaves of *panal* include glycosine, arborine, glycosminine, arborinine (major), glycosamine, glycorine, glycosmicine, g-fagarine triterpenes, arbinol and isoarbinol, arborinone, two isomeric terpene alcohols, myricyl alcohol, stigmasterol and ß-sitosterol. Studies on the allelopathic proclivities of *panal* have not been undertaken and hence, supporting results are not available. However, the Kerala Agricultural University has recommended covering of ginger rhizomes with *panal* leaves while storing (KAU, 2011).

It can be concluded that leaf loppings of *panal*, rubber, teak, *matty*, wild jack and jack resulted in higher yield of ginger and hence, can be recommended to farmers for applying as mulch in ginger @ 15 Mg ha^{-1}(100 g per grow bag of 25 cm height and 30 cm diameter, capable of holding 15 kg potting mixture comprising of soil:sand:cow dung in 1:1:1 ratio) immediately after planting and subsequently @ 7.5 Mg ha^{-1} (50 g per grow bag) each at 44-60 and 90-120 DAP. Mulching with mango and tamarind leaves adversely affected growth and yield of ginger and are hence, cannot be recommended for mulching. Another interesting observation was that in the control where newspaper were used as mulch, the yield was high (637 g plant^{-1}) and comparable to mulching with *panal*, rubber, teak, *matty*, wild jack and jack leaves. Hence, when ginger is grown in homesteads and terrace gardens, if available, newspaper can be used for mulching.

Acknowledgement

The authors are grateful to the Kerala Agricultural University for the research grant and facilities provided for undertaking the study.

References

Bhadoria, P. B. S. 2011. Allelopathy: a natural way towards weed management. Amer. J. Exp. Agric., 1: 7–20.

Bhatt, B.P. and Todaria, N.P. 1990. Studies on the allelopathic effects of some agroforestry tree crops of Garhwal Himalaya. Agrofor. Syst., 12: 251-255.

Duke, J.A. 1992. Handbook of Phytochemical Constituents of Grass Herbs and Other Economic Plants. CRC Press, Boca Raton, Florida, 352p.

El-Rokiek, Kowthar, G., El-Masry, R.R., Nadia, K.M. and Salah, A.A. 2010. The allelopathic effect of mango leaves on the growth and propagative capacity of purple nutsedge (*Cyperus rotundus* L.). J. Am. Sci. [e-journal] 6. Available: http://www.jofamericanscience.org/journals/amsci/am0609/16 2865 am0809 151 159.pdf. ISSN: 1545-1003 [5 June 2015].

KAU (Kerala Agricultural University). 2009. Final Report KSCSTE Project: Investigation on the allelopathic interactions and potential threat of soil sickness due to multipurpose trees in home gardens of Kerala. Kerala Agricultural University, Thrissur, 156p.

KAU (Kerala Agricultural University). 2011. Package of Practices Recommendations: Crops (14th Ed.). Kerala Agricultural University, Thrissur, 360p.

Panse, V.G. and Sukhatme, P.V. 1985. Statistical Methods for Agricultural Workers (4th Ed.). Indian Council of Agricultural Research, New Delhi, India, 347p.

Sahoo, U. K., Jeeceelee, L., Vanlalhriatpuia, K., Upadhyaya, K. and Lalremruati, J.H. 2010. Allelopathic effects of leaf leachate of *Mangifera*

indica L. on initial growth parameters of few homegarden food crops. World J. Agric. Sci. [e-journal] 6(5). Available: http://www.idosi.org/wjas/wjas6(5)/16.pdf. ISSN: 1817-3047 [19 July 2015].

Sreejith, P.S., Praseeja, R.J. and Asha, V.V. 2012. A review on the pharmacology and phytochemistry of traditional medicinal plant, *Glycosmis pentaphylla* (Retz.) Correa. J. Pharm Res., 5(5): 2723-2728.