Journal of Agricultural Engineering and Food Technology
p-ISSN: 2350-0085; e-ISSN: 2350-0263; Volume 4, Issue 1; January-March, 2017 pp. 17-21

http://www.krishisanskriti.org/Publication.html

Influence of Planting Methods, Intercrop and Integrated Weed Management Practices on Yield and Economics of Turmeric

Dwijendra Mohan Barman[1], Jayanta Deka[2] and Niren Das[3]

[1]Spices Board, Govt. of India, Kalimpong, West Bengal
[2]Department of Agronomy, Assam Agricultural University, Jorhat, Assam
[3]Rain Forest Research Institute, Jorhat, Assam
E-mail: [1]dwijendra.barman@nic.in, [2]jayantadeka.2008@rediffmail.com, [3]dasn@icfre.org

Abstract—*A field experiment was conducted during 2013 and 2014 to study the effect of planting methods, intercrop and integrated weed management practices on yield and economics of turmeric. Two planting methods of turmeric viz., paired row 80/20 cm and paired row 70/30 cm; two intercropping systems with baby corn and greengram and three weed management practices viz., non-chemical i.e. mulching along with four hand weeding at 35, 65, 95 and 140 days after planting (DAP), pre-emergence application of metribuzin @ 500 g ha^{-1} along with five hand weeding at 35, 65, 95, 140 and 185 DAP and pre-emergence application of oxadiargyl @ 90 g ha^{-1} along with five hand weeding at 35, 65, 95, 140 and 185 DAP along with one weedy check (control) were evaluated. Turmeric planting in paired row 70/30 cm and intercropping greengram in between paired rows with non-chemical weed management practice by mulching along with four hand weeding at 35, 65, 95 and 140 DAP ($M_2I_2W_2$) proved superior in most of the attributes studied, followed by paired row 70/30 cm and intercropping baby corn with non-chemical weed management practice by mulching along with four hand weeding at 35, 65, 95 and 140 DAP($M_2I_1W_2$). The later treatment combination ($M_2I_1W_2$) was found superior in terms of net return (` ha^{-1}), benefit: cost ratio and monetary advantage.*

Keywords*: Turmeric, intercrop,weeds, integrated weed management, yield and economics.*

1. INTRODUCTION

Turmeric has been famed and valued for its attractive colour and medicinal properties. The virtue of turmeric gives it the name “golden spice” and “spice of life”. The position of turmeric in religious and socio-cultural association is also enormous. India is the largest producer, consumer and exporter of turmeric in the world. Turmeric occupies about 6% of the total area under spices and condiments in the country. Because of high Curcumin content of Indian turmeric, it is regarded as the best in the world. Though India is in dominant position as far as production; trade etc. of turmeric is concerned, its mean productivity is quite low in comparison to the competitor countries. Moreover, increased cost of production and less productivity may lead against India in the future even though country has potential. The variation in productivity level is very prominent among the producing states within the country. There are many factors responsible for low productivity of turmeric in the country. The two major such factors are use of marginal or low productive land for turmeric cultivation and weed infestation. As turmeric is a long duration crop, the marginal and small farmers can hardly spare productive land for cultivation of turmeric without a mid-term income. On the other hand being a rainy season crop and characterized by delayed emergence, slow initial growth, poor canopy development, turmeric gets tough competition from weeds for production factors. Yield losses of turmeric due to weeds vary from 30-75 per cent [5]. Short duration and price fetching suitable intercrop with turmeric may result in sustainable turmeric cultivation for the small and marginal farmers and boost the higher productivity. Simultaneously, suitable integrated weed management practice will check the yield losses. Keeping these in view, the present investigation was undertaken to develop a suitable intercropping and weed management system in turmeric.

2. MATERIALS AND METHODS

A field experiment was conducted during 2013 and 2014 in the Instructional-cum- Research Farm of Assam Agricultural University, Jorhat. The soil of the experimental site belonged to taxonomic order of inceptisol with sandy loam texture. The surface soil, in both the years of experimentation was acidic in reaction, low in organic carbon, medium in available nitrogen and potassium, and low in phosphorus. The experiment was laid out in a factorial randomized block design with three replications and it consisted twenty treatment combinations including four controls (sole crops) *viz.*$M_1I_1W_1$-80/20 cm; Baby corn; weedy check, $M_1I_1W_2$-80/20 cm; baby corn; mulching + 4HW at 35, 65, 95, 140 DAP, $M_1I_1W_3$ -80/20 cm; baby corn; metribuzine (PE) + 5HW at 35, 65, 95, 140 and

185 DAP, $M_1I_1W_4$ -80/20 cm; baby corn; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP, $M_1I_2W_1$ -80/20 cm; greengram; weedy check, $M_1I_2W_2$ -80/20 cm; greengram; mulching + 4HW at 35, 65, 95 and 140 DAP, $M_1I_2W_3$ -80/20 cm; greengram; metribuzine (PE) + 5HW at 35, 65, 95, 140 and 185DAP, $M_1I_2W_4$ -80/20 cm; greengram; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP, $M_2I_1W_1$ -70/30 cm; baby corn; weedy check, $M_2I_1W_2$ -70/30 cm; baby corn; mulching + 4HW at 35, 65, 95 and 140 DAP, $M_2I_1W_3$ -70/30 cm; baby corn; metribuzine (PE) + 5HW at 35, 65, 95, 140 and 185 DAP, $M_2I_1W_4$ -70/30 cm; greengram; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP, $M_2I_2W_1$ -70/30 cm; greengram; baby corn; weedy check, $M_2I_2W_2$ -70/30 cm; greengram; mulching + 4HW at 35, 65, 95 and 140 DAP, $M_2I_2W_3$ -70/20 cm; greengram; metribuzin (PE) + 5HW at 35, 65, 95, 140 and 185 DAP, $M_2I_2W_4$ -70/30 cm; greengram; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP.

Turmeric variety *Lakadong*, baby corn variety G 5414 and greengram variety *Pratap*(SG-1) were planted same day according to the planting method adopted. All other recommended package of practices was followed to raise the crops as per the package of practice of Assam Agricultural University. The data on weed count and dry weight was subjected to square root $\sqrt{(x + 0.5)}$ transformation before statistical analysis to normalize their distribution.

3. RESULTS AND DISCUSSION

3.1 Effect on weeds

During both the years of experimentation, Elusine indica (L.) Gaertn., Digitaria setigera Roth., Panicum repens L., Cyperus iria L., Fimbristylis aestivalis (Retz.) Vahl., Borreria articularis (L. f.) Will, Commelina diffusa Burm.f., Ageratum houstonianum Mill, Mimosa diplotricha C Wright. and Mimosa pudica L. were the dominant weed flora which resulted significant yield loss in weedy check control and caused a lot of management problems in other treatments. In 2013, the relative density of grasses was higher in initial growth stages of the crops but at later growth stages, broad leaved weeds dominated over other types. However, in 2014, both grasses and broad leaved weeds dominated equally in all the growth stages of turmeric. Higher population of grass and broad leaved weed flora occurred due to high rainfall [2,6]. Higher weed continuum recorded during both the years might be due to sufficient rainfall received during cropping period which resulted in advantageous field environment for weed growth. The weed density and dry weight was recorded at 150 DAP and 180 DAP. All the weed control treatments recorded significantly lower weed density and dry weight (Table.1) and higher weed control efficiency (Table.4) than un-weeded check. Among the various treatments, paired row planting 70/30 cm, intercropping greengram and non-chemical weed control method i.e. mulching along with four hand weeding at 35, 65, 95 and 140 DAP recorded significantly lower weed density and weed dry weight and higher weed control efficiency.

3.2. Effect on crop

Planting method of paired row 70/30 cm produced higher leaf area index (15.43 and 23.25 cm at 140 and 185 DAP, respectively) and number of tillers (4.14 and 4.95 at 140 and 185 DAP, respectively) than paired row 80/30 cm. This might be due to the fact that wider inter-row spacing i.e. 30 cm in paired row 70/30 cm reduces intra-row competition thereby enhancing higher tillering than that in 80/30 cm. Similarly, intercropping turmeric with greengram (I_2) recorded significantly higher leaf area index and tillers per plant over that in baby corn (I_1).This might be due to the synergistic effect of leguminous intercrop greengram on turmeric that enhances higher tillering and more number of leaves in turmeric, while on the contrary, baby corn being a highly exhaustive crop, might have exploited more soil resources, thereby affecting the tillering of base crop. Weed management practices had significant effect on LAI and number of tillers. The highest value of LAI and number of tillers was achieved in non-chemical weed control treatment (W_2) which was statisticallysuperior to all other practices. Better weed control in W_2 might have reduced the crop-

Table 1: Total weed density and dry weight at 150 and 180 DAP as influenced by planting methods, intercropping and weed management practices in turmeric

Treatments	Total weed density (No. m^{-2})		Total dry weight ($g\ m^{-2}$)	
	150 DAP	180 DAP	150 DAP	180 DAP
Planting Methods (M)				
M_1 : Paired row 80/20 cm	3.7 (40.3)	9.65 (98.45)	11.20 (125.5)	12.75 (162.6)
M_2 : Paired row 70/30 cm	3.55 (36.8)	9.35 (92.75)	10.85 (117.85)	12.5 (156.15)
SEd (±)	0.023	0.055	0.011	0.014
CD (P=0.05)	0.05	0.11	0.03	0.03
Intercropping (I)				
I_1 : Baby corn	3.65 (38.3)	9.60 (97.05)	11.25 (124.35)	12.7 (160.55)
I_2 : Greengram	3.60 (38.1)	9.45 (93.75)	10.9 (117.2)	12.6 (158.26)
SEd (±)	0.026	0.055	0.011	0.014
CD (P=0.05)	NS	0.12	0.12	0.03
Weed management (W)				
W_1 : Weedy check (Control)	12.35 (152.85)	12.12 (148.10)	22.05 (486.6)	22.95 (525.95)

W_2 : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	0.70 (0.0)	5.55 (31.15)	0.70 (0.0)	3.7 (13)
W_3 : Pre-emergence application of metribuzin @ 500 g ha^{-1} + hand weeding at 35, 65, 95, 140 and 185 DAP	0.70 (0.0)	9.85 (96.40)	0.70 (0.0)	6.75 (45)
W_4 : Pre-emergence application of oxadiargyl @ 90 g ha^{-1} + hand weeding at 35, 65, 95, 140 and 185 DAP	0.70 (0.0)	10.40 (107)	0.70 (0.0)	7.35 (53.55)
SEd (±)	0.033	0.078	0.016	0.019
CD (P=0.05)	0.07	0.16	0.03	0.04
Treatment Mean	3.6	9.5	11.05	12.65
Control (C)				
C : (Sole turmeric)	5.63 (31.18)	6.85 (46.70)	4.10 (16.5)	3.80 (27.6)
SEd (±) between				
Treatment mean vs. C_1	0.062	0.050	0.005	0.059
CD (P=0.05) between				
Treatment mean vs. C_1	0.12	0.09	0.01	0.12

Figures in parenthesis are mean of original values; Data subjected to square root transformation weed competition causing higher number of tillers and leaves per plant that eventually lead to significantly higher value of LAI [3,4].Number of rhizomes/plant, weight of rhizome/plant and fresh rhizome yields were significantly influenced by the different planting methods, intercrop and weed management practice (Table.3). The paired row planting 70/30 cm of planting method recorded higher number of rhizomes/plant, intercropping greengram and non-chemical weed control method *i.e.* mulching along with four hand weeding at 35, 65, 95 and 140 DAP recorded significantly lower weed density and weed dry weight.

3.2.1. Land equivalent ratio (LER)

The data pertaining to land equivalent ratio are presented in Table 4 and perusal of the data on LER, revealed that the treatment combination of $M_2I_1W_2$ i.e.planting of turmeric paired row of 70/30 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching followed by four hand weeding at 35, 65, 95 and 140 DAP recorded highest values (1.58) followed by planting of turmeric paired

Table 2: Leaf area index and number of tillers at 140 DAP and 185 as influenced by planting methods, intercropping and weed management practices in turmeric

Treatments	Leaf area index No. of tillers $plant^{-1}$			
	140 DAP	185 DAP	140 DAP	185 DAP
Planting Methods (M)				
M_1 : Paired row 80/20 cm	14.31	21.66	3.94	4.61
M_2 : Paired row 70/30 cm	15.43	23.25	4.14	4.95
SEd (±)	0.271	0.114	0.081	0.112
CD (P=0.05)	0.56	0.23	0.16	0.221
Intercropping (I)				
I_1 : Baby corn	14.56	22.05	3.78	4.23
I_2 : Greengram	15.18	22.84	4.30	4.91
SEd (±)	0.271	0.114	0.091	0.112
CD (P=0.05)	0.56	0.23	0.18	0.223
Weed Management (W)				
W_1 : Weedy check (Control)	5.64	7.68	2.01	2.46
W_2 : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	22.66	32.87	5.86	6.33
W_3 :Pre-emergence application of metribuzin @ 500 g ha^{-1} + hand weeding at 35, 65, 95, 140 and 185 DAP	16.70	30.92	4.28	5.38
W_4 :Pre-emergence application of oxadiargyl @ 90 g ha^{-1} + hand weeding at 35, 65, 95, 140 and 185 DAP	14.45	23.36	4.02	5.09
SEd (±)	0.384	0.161	0.128	0.158
CD (P=0.05)	0.78	0.33	0.26	0.32
Treatment Mean	14.87	22.44	4.05	4.82
Control (C)				
C : (Sole turmeric)	29.90	40.05	5.85	6.90
SEd (±) between				
Treatment mean vs. C	0.087	0.275	0.147	0.201
CD (P=0.05) between				
Treatment mean vs. C	0.19	0.59	0.30	0.39

row of 80/20 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching followed by four hand weeding at 35, 65, 95 and 140 DAP (1.55). This could be due to the fact in this treatment combination $M_2I_1W_2$, turmeric yield was significantly highest and the additive yield due to intercrop baby corn was overwhelmingly more.

3.2.2 Economics

The economics was worked out based on the total cost of cultivation (Table 4.). A perusal of the data on cost of cultivation, revealed that the treatment combination of planting of turmeric paired row of 70/30 cm, intercropping baby corn and non-chemical weed management practice i.e. mulching along with four hand weeding at 35, 65, 95 and 140 DAP ($M_2I_1W_2$)recorded highest values (`219714/-) followed by planting of turmeric paired row of 70/30 cm and intercropping baby corn along with weed management practice of application metribuzin (PE) and five hand weeding at 35, 65, 95, 140 and 185 DAP (`219523/-). The relatively higher cost of cultivation in the treatment combination of $M_2I_1W_2$, was due to higher cost of mulch materials and seeds of baby corn. A perusal of the data on net return, revealed that the treatment combination of planting of turmeric in paired row of 70/30 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching with four hand weeding at 35, 65, 95 and 140 DAP ($M_2I_1W_2$) recorded

highest values (`670988.5/-) of net return followed by planting of turmeric in paired row of 80/20 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching with four hand weeding at 35, 65, 95 and 140 DAP (`647987/-). This could be due to the fact in this treatment combination ($M_2I_1W_2$), the proportionate increase in net return due to incremental increase in cost of cultivation was higher. The net return obtained under the treatment combination of $M_2I_1W_2$ and $M_1I_1W_2$ was higher than that of the control i.e. sole turmeric (C). It is evident with the statement that net return in intercropping turmeric by proper planting geometry fetches higher than sole turmeric [1].

Table 3: Number of total rhizome per plant, weight of rhizome per plant and fresh rhizome yield as influenced by planting methods, intercropping and weed management practices in turmeric

Treatments	No. of total rhizome/plant	Weight of rhizome (g/plant)	Fresh rhizome yield (t/ha)	
Planting Methods (M)				
M_1 : Paired row 80/20 cm	17.99	341.56	23.87	
M_2 : Paired row 70/30 cm	18.88	356.60	24.44	
SEd (±)	0.195	0.528	0.074	
CD (P=0.05)	0.39	1.08	0.15	
Intercropping (I)				
I_1 : Baby corn	17.41	339.92	23.8	
I_2 : Greengram	19.16	358.24	24.515	
SEd (±)	0.195	0.528	0.074	
CD (P=0.05)	0.39	1.08	0.15	
Weed Management (W)				
W_1 : Weedy check (Control)	13.48	193.95	12.32	
W_2 : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	24.58	461.36	32.24	
W_3 :Pre-emergence application of metribuzin @ 500 g ha^{-1} + hand weeding at 35, 65, 95, 140 and 185 DAP	16.81	389.68	26.67	
W_4 :Pre-emergence application of oxadiargyl @ 90 g ha^{-1} + hand weeding at 35, 65, 95, 140 and 185 DAP	18.20	351.33	25.41	
SEd (±)	0.275	0.746	0.105	
CD (P=0.05)	0.56	1.52	0.22	
Treatment Mean	22.33	349.08	24.16	
Control (C)				
C : (Sole turmeric)	27.33	549.30	36.97	
SEd (±) between				
Treatment mean vs. C	0.320	0.718	0.113	
CD (P=0.05) between				
Treatment mean vs. C	0.71	1.54	0.31	

The treatment combination of $M_2I_1W_2$ i.e.planting of turmeric paired row of 70/30 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching with four hand weeding at 35, 65, 95 and 140 DAP recorded highest values of B:C ratio (4.05) and monetary advantage (□843623/-) followed by planting of turmeric paired row of 80/20 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching with four hand weeding at 35, 65, 95 and 140 DAP. This is evident from the fact that in the treatment combination of $M_2I_1W_2$, the relative gross return due to investment in cultivation was higher and the LER was much more (Table 4).

It was concluded that planting turmeric in paired row 70/30 cm, intercropping baby corn in between paired rows along with weed management practice *viz*., mulching along with hand weeding at 35, 65, 95 and 140 DAP proved superior combination, followed by planting turmeric in paired row 80/20 cm intercropping baby corn in the intermediate space between paired rows and weed management practice *viz*., mulching along with four hand weeding at 35, 65, 95 and 140 DAP.

Table 4: Weed control efficiency, LER and economics as influenced by planting methods, intercropping and weed management practices in turmeric

Treatments	Weed control efficiency (at 180 DAP)	LER	Total cost of cultivation (`ha^{-1})	Net return (`ha^{-1})	BCR	Monetary advantage (`ha^{-1})
$M_1I_1W_1$	0	0.77	147242.5	244423.5	2.66	-201800
$M_1I_1W_2$	83.5	1.55	219427.5	647987	3.95	778735.5
$M_1I_1W_3$	69	1.26	219384	491085	3.24	325536.5
$M_1I_1W_4$	68	1.24	218879	476800.5	3.18	301611
$M_1I_2W_1$	0	0.46	144832.5	116964	1.81	-478598
$M_1I_2W_2$	84.5	1.07	217165	455155	3.095	84289.5
$M_1I_2W_3$	70.5	0.88	217103.5	342755	2.58	-148470
$M_1I_2W_4$	68.5	0.84	216353	311590.5	2.44	-197533
$M_2I_1W_1$	0	0.79	147462	260315	2.77	-188706
$M_2I_1W_2$	84.5	1.58	219713.5	670988.5	4.055	843622.5
$M_2I_1W_3$	72.5	1.27	219523	501545	3.285	348014
$M_2I_1W_4$	65.5	1.24	218919.5	480214	3.195	303108
$M_2I_2W_1$	0	0.48	145002.5	129350	1.89	-473912

$M_2I_2W_2$	88	1.10	217388	471788.5	3.17	118985.5
$M_2I_2W_3$	74.5	0.89	217188.5	348963	2.61	-142685
$M_2I_2W_4$	69.5	0.84	216410.5	315585	2.46	-191508
C_1 (sole turmeric)	-	-	199012	540321.5	3.715	-
C_4 (sole turmeric)	-	-	213001.5	570332	3.675	-
C_2 (sole baby corn	-	-	50620	179780	4.55	-
C_3 (sole greengram)	-	-	32284	39716	2.23	-

4. ACKNOWLEDGEMENTS

This work was supported in part by a grant from the Spices Board, Ministry of Commerce and Industry, Govt. of India.

REFERENCES

[1] Behera, B., Mohanty, S.K., Mishra, A., and Dash, D.K.,"Impact of planting geometry on productivity and profitability of turmeric (*Curcuma longa*) and pigeonpea (*Cajanus cajan*) intercropping under rainfed condition",*Journal of spices and aromatic crops,*17,2,2008, pp. 154-157.

[2] Bhuvaneswari, J., *Weed management in organically grown maize-sunflower cropping system*,Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India, Doctoral Thesis, 2009.

[3] Hashim, S.,Marwat, K.B., and Hassan, G.,"Chemical weed control efficiency in potato (*Solanum tuberosum* L.) under agro-climatic conditions of Peshawar, Pakistan", *Pakistan Journal of Weed Science Research,*9,1-2,2003, pp.105-110.

[4] Jan, H., Muhammad, A., and Ali, A.,"Studies on weed control in potato in Pakhal plains of Mansehra", *Pakistan Journal of Weed Science Research,*10, 3-4, September2004, pp.157-160.

[5] Krishna murthy, V.V., and Ayyaswamy, M., "Role of herbicide on yield of turmeric", *Spice India*13**,** 2000, pp.9-11.

[6] Sathiyavani, E.,and Prabhakaran,N.K., "Performance of pre-emergence Herbicides on weed flora and yield of Turmeric", *Trends in Biosciences,***7,** 12, July 2014, pp. 1350-1353.