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Effect of Inter-Cropping and Weed Management on the Economics of Ginger Production

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A B S T R A C T

A field experiment was conducted in the year 2013-14 and 2014-15 in Assam Agricultural University, Jorhat district, Assam, India to analyse the total cost and profit due to different treatment combinations of inter-cropping systems and chemical weed management practices in ginger. There were 16 numbers of treatment combinations, comprising of 4 inter-cropping systems and 4 weed management practices. Intercropping of Cowpea in between rows of Ginger and incorporated at 40 days after sowing (DAS) along with the application of Metribuzin 500 g ai ha^{-1} + hand weeding (HW) at 70, 100 and 140 days after planting (DAP) recorded higher ginger rhizome yield, gross return, net return and benefit : cost ratio.

Introduction

Ginger (*Zingiber officinale* Rosc.) is an important commercial crop grown for its aromatic rhizome. It is used as a spice and is also known for its medicinal benefits since several years across the globe. In the global scenario, India ranks first in terms of ginger production.

And amongst the North-eastern states, Assam has the highest production (Rahman *et al.*, 2009). But ginger being a widely spaced crop, weeds act as a major competitor for the available resources. Controlling weeds through hand weeding is a time consuming process and expensive due to labour scarcity.

Therefore, growing of intercrops and application of pre-emergence herbicide can be a cost effective approach towards better weed management during the critical period of crop weed competition.

Thus, the current study was initiated with the intent to analyse the total cost incurred in the

various inputs utilized in its production and also the profit that can be obtained under different treatment combinations of inter-cropping systems and weed management practices.

Materials and Methods

Field preparation

The experimental plots were prepared adequately and demarcated into 20 m^2 sub-plots, comprising of 3 replications and 16 treatment combinations totalling to 48 numbers of sub-plots, accounting for a net area of 960 m^2 and gross area 1482 m^2.

Farm yard manure @ 10 t ha^{-1} was applied during the time of bed preparation and recommended dose of $N:P_2O_5:K_2O$ @ 75:50:50 kg ha^{-1} in the form of urea (46% N), single super phosphate (16% P_2O_5) and murate of potash (60% K_2O) were applied.

Treatment details

Treatment combination comprised of 4 Cropping Systems *viz.*, I_1: Ginger + Cowpea (2:1); Cowpea incorporated at 40 days after sowing, I_2: Ginger + Cowpea (3:1); Cowpea incorporated at 40 days after sowing, I_3: Cowpea in between rows of Ginger and incorporated at 40 days after sowing, I_4: Cowpea in between alternate rows of Ginger and incorporated at 40 days after sowing and 4 Weed Management Practices *viz.*, W_1: Weedy (Control), W_2: Hand weeding at 40, 70, 100 and 140 days after planting, W_3: Pre-emergence application of Oxadiargyl 90 g ai ha^{-1} + hand weeding at 70, 100 and 140 days after planting and W_4: Pre-emergence application of Metribuzin 500 g ai ha^{-1} + hand weeding at 70, 100 and 140 days after planting.

Planting and sowing operations followed by herbicide application

Mancozebpre-treated 'Nadia' rhizomes of ginger were planted with a seed rate of 1800 kg ha^{-1}. Good quality fodder variety of cowpea 'UPC-278' were sown in between the rows of ginger as per the treatment requirement maintaining a spacing of 5 cm between cowpea plants. Cowpea was sown on the same days of ginger rhizome planting. The pre-emergence herbicides *viz.*, metribuzin and oxadiargyl were applied on the 3rd day after rhizome planting with a spray volume of 500 L ha^{-1}.Rice straw @ 4 t ha^{-1} were mulched in two splits. First mulching was done after the application of pre-emergance herbicide and second mulching at 70 DAP. Hand weeding aided with hand blade (*Khurpi*) was done as per the treatment schedule. Light earthing up was done at 60 and 100 DAP for all the ginger plots except the weedy treatments. Need based plant protection measures were adopted to manage insect and diseases as recommended by Assam Agricultural University.

Total cost of cultivation

The totalcost of cultivation was calculated in hectare basis for each treatment combinations by adding individual cost incurred on the following inputs and field operations.

a = Cost of land preparation
b = Cost of bed preparation
c = Cost of fertilizer
d = Cost of ginger and cowpea
e = Cost of ginger planting
f = Cost of cowpea sowing
g = Cost of herbicide and its application
h = Cost of mulch ad mulching
i = Cost of weeding
j = Cost of harvesting

Gross return and net return

Gross return is the value of the economic yield calculated at prevailing price. Net return was calculated by subtracting the cost of cultivation from the gross return on per hectare basis. Benefit-cost ratio was computed by dividing the net return by total cost of cultivation during the experiment.

Results and Discussion

Rhizome yield of ginger (kg ha^{-1})

In both the years of experimentation (2013-14 and 2014-15), highest ginger yield of 7542 and 8633 kg ha^{-1} was recorded in the treatment Cowpea in between Ginger and incorporated at 40 DAS (I_3) which was statistically *at par* with the treatment Cowpea in alternate rows and incorporated at 40 DAS (I_4).

Amongst the weed management treatments, Metribuzine 500 g ha^{-1} pre-em+ HW 70, 100 and 140 DAP recorded significantly highest ginger yield of 7817 and 9340kg ha^{-1} in 2013-14 and 2014-15, respectively (Table 1).

Restricting the weeds below economic threshold level due to weed smothering ability of higher density of cowpea inter cropped in between all the rows of ginger with better weed control by Metribuzin could have helped the crop to put better vegetative growth and finally a higher fresh rhizome yield. Tewari *et al.,* (1988) reported similar findings from a study on potato.

Economics

Total expenditure incurred and total returns were worked out on hectare basis for each treatment combinations by taking into account all the cultural operations, labour wages and prices of product fixed by Assam Agricultural University and prevailing prices of other inputs as listed in Table 2.

Cost of cultivation (Rs.ha^{-1})

In both the years of experimentation, the lowest cost of cultivation of Rs. 1,04,774/- was obtained from the treatment combinations of intercropping systems with the weedy check, as there was no labour cost in these treatments. Whereas, the highest cost of cultivation of Rs. 1,71,774/- was incurred in the treatment combinations of intercropping systems with hand weeding at 40, 70, 100 and 140 DAP, as more number of labours were required in this treatment to remove weeds at 40, 70, 100 and 140 DAP (Table 3). Aliyu and Lagoke (2000) also recorded a higher cost of cultivation in hand weeded plot over herbicide treated plot.

Gross return (Rs.ha^{-1})

The highest gross return of Rs9,30,000/- and Rs 11,63,333/- per hectare in 2013-14 and 2014-15, respectively (Table 4) was obtained with the treatments combination of Cowpea in between Ginger and incorporated at 40 DAS and Metribuzin 500 g ha^{-1} pre-em+ HW 70, 100 and 140 DAP (I_3W_4).

Amongst treatment of inter-cropping systems of Cowpea in between Ginger and incorporated at 40 DAS and amongst weed management practices 'Metribuzin 500 g ha^{-1} pre-em+ HW 70, 100 and 140 DAP individually recorded higher rhizome yield which together contributed towards higher gross return in this treatment combination.

Net return (Rs.ha^{-1})

The highest net return of Rs7,61,425/- and Rs 9,94,759 /- per hectare in 2013-14 and 2014-15, respectively (Table 4) was obtained with the treatment combination of Cowpea in between Ginger and incorporated at 40 DAS and Metribuzin 500 g ha^{-1} pre-em+ HW 70, 100 and 140 DAP (I_3W_4).

The treatment combination of Cowpea in between Ginger and incorporated at 40 DAS and Metribuzin 500 g ha^{-1} pre-em+ HW 70, 100 and 140 DAP recorded higher gross return, thus contributing towards higher net return.

Sanwal *et al.*, (2006) recorded highest net in Ginger: Cowpea intercropping plots, in comparison to other treatments.

Benefit cost ratio (B:C)

The highest benefit cost (B:C) ratio 4.52 and 5.90 per hectare in 2013-14 and 2014-15, respectively was obtained with the treatments combination of Cowpea in between Ginger and incorporated at 40 DAS and Metribuzin 500 g ha^{-1} pre-em+ HW 70, 100 and 140 DAP (I_3W_4). This treatment combination recorded highest gross return and net return, ultimately resulting in higher benefit: cost ratio (Table 4).

Table.1 Fresh rhizome yield (kg ha^{-1}) of ginger

Treatments	2013-14	2014-15
Cropping system		
I_1 :G*+C* (2:1); C incorp. 40 DAS	5846	6175
I_2 :G+C (3:1); C incorp. 40 DAS	5925	6454
I_3 :C in between G; incorp. 40 DAS	7542	8633
I_4 :C in alternate rows; incorp. 40 DAS	7338	8505
$CD_{P=0.05}$	419	635
Weed management		
W_1 :Weedy	5021	4825
W_2 :HW 40, 70, 100 and 140 DAP	6533	7396
W_3 :Oxadiargyl 90 g ha^{-1} pre-em+ HW 70, 100 and 140 DAP	7279	8208
W_4 :Metribuzine 500 g ha^{-1} pre-em+ HW 70, 100 and 140 DAP	7817	9340
$CD_{P=0.05}$	338	635

G*=Ginger, C* Cowpea, pre-em=Pre-emergence

Table.2 Unit cost of inputs

Sl. No.	Item	Unit	Cost (Rs.₹)
1	Farm Yard Manure (FYM)	ton	1000/-
2	Seed Rhizome	kg	30/-
3	Cowpea seeds	kg	300/-
4	Tractor (ploughing)	ha	2800/-
5	Tractor (harrowing)	ha	1000/-
6	Urea	kg	9/-
7	Single Super Phosphate (SSP)	kg	10.5/-
8	Mutare of Potash (MoP)	kg	12/-
9	Metribuzin	kg	2100/-
10	Oxadiargyl	kg	7285/-
11	Paddy straw	ton	1000/-
14	Labour	man day	134/-

Table.3 Total cost of cultivation (Rs ha^{-1})

Treatments	Cost of land preparation	Cost of bed preparation	Cost of fertilizers	Cost of herbicide and mulch	Cost of Ginger & Cowpea	Cost of planting and sowing	Cost of herbicide application	Cost of mulching	Cost of weeding	Cost of harvesting	Total Cost of Cultivation
I_1W_1	5000	16750	2775	10,000	43315	6700	134	3350	------	16750	104774
I_1W_2	5000	16750	2775	10,000	43315	6700	134	3350	67000	16750	171774
I_1W_3	5000	16750	2775	10,728	57825	6700	134	3350	50250	16750	170262
I_1W_4	5000	16750	2775	11,050	57825	6700	134	3350	48240	16750	168574
I_2W_1	5000	16750	2775	10,000	43315	6700	134	3350	------	16750	104774
I_2W_2	5000	16750	2775	10,000	43315	6700	134	3350	67000	16750	171774
I_2W_3	5000	16750	2775	10,728	57825	6700	134	3350	50250	16750	170262
I_2W_4	5000	16750	2775	11,050	57825	6700	134	3350	48240	16750	168574
I_3W_1	5000	16750	2775	10,000	43315	6700	134	3350	------	16750	104774
I_3W_2	5000	16750	2775	10,000	43315	6700	134	3350	67000	16750	171774
I_3W_3	5000	16750	2775	10,728	57825	6700	134	3350	50250	16750	170262
I_3W_4	5000	16750	2775	11,050	57825	6700	134	3350	48240	16750	168574
I_4W_1	5000	16750	2775	10,000	43315	6700	134	3350	------	16750	104774
I_4W_2	5000	16750	2775	10,000	43315	6700	134	3350	67000	16750	171774
I_4W_3	5000	16750	2775	10,728	57825	6700	134	3350	50250	16750	170262
I_4W_4	5000	16750	2775	11,050	57825	6700	134	3350	48240	16750	168574

Table.4 Benefit : Cost Ratio under different treatment combinations

Treatments	Total cost of cultivation (Rs.)	Gross return (Rs.)		Net return (Rs.)		B: C ratio	
		2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
I_1W_1	104774.00	481666.67	441666.67	376892.67	336892.67	3.60	3.22
I_1W_2	171774.00	601666.67	650000.00	429892.67	478226.00	2.50	2.78
I_1W_3	170262.00	625000.00	680000.00	454738.00	509738.00	2.67	2.99
I_1W_4	168574.00	630000.00	698333.33	461426.00	529759.33	2.74	3.14
I_2W_1	104774.00	483333.33	486666.67	378559.33	381892.67	3.61	3.64
I_2W_2	171774.00	610000.00	660000.00	438226.00	488226.00	2.55	2.84
I_2W_3	170262.00	635000.00	706666.67	464738.00	536404.67	2.73	3.15
I_2W_4	168574.00	641666.67	728333.33	473092.67	559759.33	2.81	3.32
I_3W_1	104774.00	528333.33	506666.67	423559.33	401892.67	4.04	3.84
I_3W_2	171774.00	706666.67	830000.00	534892.67	658226.00	3.11	3.83
I_3W_3	170262.00	851666.67	953333.33	681404.67	783071.33	4.00	4.60
I_3W_4	168574.00	930000.00	1163333.33	761426.00	994759.33	4.52	5.90
I_4W_1	104774.00	515000.00	495000.00	410226.00	390226.00	3.92	3.72
I_4W_2	171774.00	695000.00	818333.33	523226.00	646559.33	3.05	3.76
I_4W_3	170262.00	800000.00	943000.00	629738.00	772738.00	3.70	4.54
I_4W_4	168574.00	925000.00	1145833.33	756426.00	977259.33	4.49	5.80

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