



Pitcher irrigation and surface cover management on bitter gourd (*Momordica charantia*) production in alfisols

Angira Prasad Mahata¹, Abantika Mondal², Arunabha Pal^{3*}, Susanta Kumar De¹

¹ Bidhan Chandra Krishi Viswavidyala, Mohanpur, West Bengal, India

² The West Bengal University of Teachers' Training, Education Planning and Administration, Kolkata, West Bengal, India

³ Centurion University of Technology and Management, Odisha, India

Abstract

Pitcher irrigation is a self-regulative, low cost and eco-friendly technique of irrigation having high potential of energy saving, water saving and very much efficient in vegetable and orchard planting. In order to assess the effectiveness of vegetable crop production by pitcher pot irrigation with mulching in different season and conserving water towards increasing of crop productivity in Red & Lateritic Zones of West Bengal. The experiment was conducted with five treatments combinations viz. T₁ - Pitcher irrigation + live mulch (black gram), T₂ - Pitcher irrigation + coco coir mulch, T₃ - Pitcher pot irrigation + jute fibre mulch, T₄ - Pitcher pot irrigation + babui grass mulch and T₅ - Pitcher pot irrigation + no mulch (i.e. control). One pitcher pot placed between four plants and each pitcher pot having capacity of 10 liter's water. All mulching materials @ 5 ton /ha were spread on the soil after transplanting of vegetables seedling. The result reveals that the application of each of treatments increased yield of vegetables.

Keywords: mulching, pitcher irrigation, vegetable cultivation, water conservation

Introduction

The dramatic increase in world population has resulted greater demand for food and fibre. According to Theib and Ahmed, (2004) ^[19] in arid and semiarid region of the world, optimizing agricultural production per unit volume of water application is of high demand recent days. Modern irrigation methods such as sprinkler and subsurface drip system may save up to about half of the water presently used by surface irrigation. There is a need to adopt traditional methods of irrigation that could have similar efficiency to that of drip irrigation with less cost (Batchelor et al., 1997) ^[5]. Thus, developing traditional, low cost, water saving technologies for sustainable crop production, particularly in semiarid and arid areas, remains a major challenge in science and engineering, which has been ignored by most international developmental programs (Bainbridge, 2001) ^[6]. A good example of such a neglected traditional method is pitcher irrigation.

Pitcher irrigation is an ancient irrigation method thought to have originated in Northern Africa and Iran (Stein, 1998 and Pal et al., 2020) ^[15, 12]. Pitcher irrigation has been mentioned in a book written some 2000 years ago in China (Sheng, 1974) ^[14]. According to Mondal, (1974), ^[7] Soomro, (2002) ^[16], pitcher irrigation method has been found very efficient method of irrigation in watermelons in the country like India and Pakistan. Similar results are also reported by Stein, (1997) ^[15], Setiawan et al. (1998) ^[17], in some of the horticultural crops in the Brazil, Germany and Indonesia. Pitcher irrigation is generally used in vegetable crop like tomato and okra in Zimbabwe (Batchelor et al., 1997) ^[5]. Pitcher irrigation, a traditional system of irrigation is an alternative to drip method which is the latest advancement and effective innovation of localized methods of irrigation and found suitable where water scarcity becomes a major stress for crop production (Adhikary et al, 2020) ^[3]. Pitcher

irrigation is a self-regulative, low cost and eco-friendly technique of irrigation having high potential of energy saving, water saving and very much efficient in orchard planting. In this method, unglazed backed earthen pitchers buried up to neck into the soil, filled with water which slowly seeps out through their pores wall into the root zone by the action of static and soil suction pressure (Adhikary and Pal 2020 and Thingujam et al., 2017) ^[3, 18]. The seepage rate is directly proportional to the pitchers conductance and potential evapo-transpiration of crops and is controlled by the moisture content in the soil matrix or its environments, namely the soil, climate and plants and the pitcher (Mondal et al., 1992) ^[8]. Mulching along with pitcher irrigation further enhances water use efficiency by checking evaporation and thereby conserves soil moisture, which in turn enhances microbial activities as a result of increased organic matter through decomposition of these residues (Adhikary and Pal 2020) ^[4]. It results in improved soil aggregation and suitability ((Pal et al., 2020) ^[10]. It also protects the soil and reduces crust formation. Mulching controls soil erosion and increases the water holding capacity. Mulching reduces salinity in the soil and regulates soil temperature. Weed control is an added advantage of mulch, and thereby reducing labour costs for weeding. There is a possibility of biomass production and nutrient cycling through live mulching of in situ grown annual legumes along with vegetables and field crops (Pain et al., 2013, Pal et al., 2020 and Adhikari et al., 2016) ^[9, 11, 2]. Alfisols are the third (13.1%) most important soil order in the world. Thirty-three percent of the soils in semi-arid tropics are Alfisols in India. Low infiltration rates on these highly fragile soils are usually caused by a surface crust. Due to aberrant weather and soil related constraints to production, crop yield on Alfisols remains low and unstable. Experimental evidence from research, however, shows the

soils are capable of producing more food with appropriate soil-and water- management systems.

Materials and Method

Aberrant weather condition, fragile agro ecosystem, mono cropping practices and also the soil related constraints are the major limiting factors for lowering crop productivity in Red and Lateritic agro ecological region occupying a vast area of five districts in the state of West Bengal. Hence, a good understanding with pitcher irrigation and mulching for improving vegetable crop production is required for the development of a suitable crop strategy in these areas. The present study was carried out at the farmer's field in the Amlasuli village, Garbeta II, Paschim Medinipur, West Bengal under Red and Lateritic Zone. The area lies with at 22°51'07.06" North Latitude and 87°10'52.58" East Longitude in the extended range of Chhotonagpur plateau of Jharkhand and Rajmahal hill of Orissa.

The area is having slightly undulating topography and the general elevation ranges from 150 to 400 m above mean sea level with a general slopes of 0.5 to 3% from west to east. The relief of the region is variable with sloping uplands in high situations having high runoff, nearly flat or concave low lands in lower situation having very slow runoff and flat or sloping lands in the medium position between valley bottom and ridges having slow to very slow runoff. The selected area falls under hot humid subtropical climate and is situated under rain shadow area. The mean annual rainfall of this zone is 1247 mm. The study area occupied under the Red and Lateritic agro climatic zones of West Bengal and is represented by the alfisols as major order in soil

classification. The initial soil test conducted before doing the experiment showed in (Table No-1) and treatments details also describe on (Table No -2). One pitcher pot placed between four plants and each pitcher pot having capacity of 10 litres water. All mulching materials @ 5 ton /ha were spread on the soil after transplanting of vegetables seedling. The experiment was continued for two years (i.e. 2011 and 2012).

Table 1: Relevant physico-chemical characteristics of study area.

Sl. No.	Particulars	Values
A)	Physical properties	
1	Bulk density (gm/cc)	1.34
2	Porosity (%)	46.27
3	Particle size distribution (%)	
	▪ Sand	65.9
	▪ Silt	14.8
	▪ Clay	19.3
4.	Water holding capacity (%)	39.67
5	Soil aggregates	
a)	Mean weight diameter (mm)	0.50
b)	Structural coefficient	0.52
c)	GMD (mm)	0.45
d)	WAS > 0.25%	57.42
e)	WAS < 0.25%	42.58
B)	Chemical Properties	
1.	Soil pH (1: 2.5 soil suspension)	6.43
2.	EC (mmhos/cm)	0.49
3.	Organic carbon (%)	0.42
4.	Total nitrogen (kg/ha)	56.62
5.	Available phosphorus (kg/ha)	18.85
6.	Available potassium (kg/ha)	235.52

Table 2: Experimental Details

Treatment Details	T ₁ - Pitcher pot irrigation + Live mulch (Black gram)
	T ₂ - Pitcher pot irrigation + Coco coir mulch
	T ₃ - Pitcher pot irrigation + Jute fibre mulch
	T ₄ - Pitcher pot irrigation + Babui grass mulch
	T ₅ - Pitcher pot irrigation + No mulch
Plot size	20 sq m.
Design	Randomized block design
Replication	4

Table 3: Effect of pitcher pot irrigation and mulching on yield and yield components of bitter gourd

Treatment	Fruit weight (g)			Length of fruit (cm)			Diameter of fruit (cm)			Yield (t/ha)		
	1 st Year	2 nd Year	Pooled	1 st Year	2 nd Year	Pooled	1 st Year	2 nd Year	Pooled	1 st Year	2 nd Year	Pooled
Pitcher + Jute fiber mulch	48.00	47.67	47.83	13.40	13.33	13.37	4.10	4.00	4.05	15.83	15.97	15.90
Pitcher + live mulch	45.50	46.00	45.75	13.00	13.00	13.00	4.00	4.00	4.00	14.71	15.06	14.89
Pitcher + Coco coir mulch	44.50	44.00	44.25	13.00	13.00	13.00	3.80	4.00	3.90	14.09	14.36	14.22
Pitcher + babui grass mulch	41.50	41.75	41.63	12.50	13.00	12.75	3.25	3.25	3.25	12.64	13.00	12.82
Pitcher + no mulch	35.75	35.50	35.63	11.25	12.00	11.63	3.00	3.00	3.00	9.24	9.29	9.26
Total	43.29	42.74	43.01	12.67	12.84	12.75	3.63	3.65	3.64	13.42	13.41	13.41
SE (m)	0.204	0.209	0.15	0.164	0.129	0.10	0.177	0.112	0.10	0.076	0.055	0.05
LSD (0.05)	0.630	0.645	0.43	0.506	0.399	0.30	0.545	0.345	0.30	0.234	0.169	0.13
YEAR * Treatment	SE (m)		0.21				1.15			0.07		
	LSD (0.05)		NS				NS			NS		

Results and Discussion

Red and Laterite region occupies vast area of five districts in the state of West Bengal. In this region major limiting factors for low productivity of the crops are aberrant weather condition, fragile agro ecosystem, mono cropping practices and also due to poor soil condition. Beside this acute water scarcity due to uneven and erratic water distribution and lack of irrigation facility associated with

high temperature and low humidity are also the prevalent in this condition for some constraints for higher production in this region. The results (Table 3 and Fig 4) of pooled data yield of bitter gourd grown in *kharif* season in 2011 and 2012 shows different variation by the application of pitcher pot irrigation with different type of mulch. The bitter gourd yields were recorded as 15.90 t/ha, 14.89 t/ha, 14.22 t/ha, 12.82 t/ha and 9.26 t/ha respectively in pitcher pot irrigation

+ jute fibre mulch, pitcher pot irrigation + live mulch, pitcher pot irrigation + coco coir mulch, pitcher pot irrigation + babui grass mulch and pitcher pot irrigation + no mulch. Significantly highest ($P<0.05$) yield was recorded in pitcher pot irrigation + jute fibre mulch. The results reveals that response of yield over control due to each treatment were 6.64 t/ha (71.71%), 5.63 t/ha (60.80%), 4.96 t/ha (53.56%) and 3.56 t/ha (38.44%) respectively in pitcher pot irrigation + jute fibre mulch, pitcher pot irrigation + live mulch, pitcher pot irrigation + coco coir mulch and pitcher pot irrigation + babui grass mulch. The yield of bitter gourd significantly increased ($P<0.05$) with the application of different types of treatments over no mulch. The data also showed variation of bitter gourd yield due to application treatment for each of the year, however, the performances of yields were much better in the first year for each of the treatments. The variations of bitter gourd yield in different years were not significant at each of the treatments. The results of fruit weight also showed similar trend of results as observed for the earlier results yield of bitter guard (Table 3 and Fig 3). Highest values (47.83 g) are observed for the treatments of pitcher pot irrigation + jute fibre mulch followed by the treatments of pitcher pot irrigation + live mulch (45.75 g), pitcher pot irrigation + coco coir (44.25 g) pitcher pot irrigation + babui grass mulch (41.63 g) and pitcher pot irrigation + no mulch (35.63 g). The effect of pooled data for 2011 and 2012 also resembles with findings (Table 3). The response of fruit weight over pot irrigation + no mulch due to each treatment were 12.20 g (34.24%), 10.12 g (28.40%), 8.62 g (24.19) and 6.00 g (16.84%) respectively in pitcher pot irrigation + jute fibre mulch, pitcher pot irrigation + live mulch, pitcher pot irrigation + coco coir mulch and pitcher pot irrigation + babui grass mulch. Significantly highest ($P<0.05$) fruit yield was recorded in plots received in pitcher pot irrigation + jute fibre mulch. The result of the effect of various mulching combination on the length of fruit of bitter gourd crop are present (Table 3 and Fig 1). The significantly highest ($P<0.05$) length of fruit of better gourd crop were observed in jute fibre mulch both the years. The results reveal that

length of fruit of bitter gourd were recorded as 13.37 cm, 13.00 cm, 13.00 cm, 12.75 cm and 11.63 cm respectively in pitcher pot irrigation + jute fibre mulch, pitcher pot irrigation + live mulch, pitcher pot irrigation + coco coir mulch, pitcher pot irrigation + babui grass mulch and pitcher pot irrigation + no mulch. The results also found that response length of fruit of bitter gourd over control due to each treatment were 1.74 cm (14.96%), 1.37 cm (11.78%), 1.37 cm (11.78%) and 1.12 cm (9.63%) respectively in pitcher pot irrigation + jute fibre mulch, pitcher pot irrigation + live mulch, pitcher pot irrigation + coco coir mulch, and pitcher pot irrigation + babui grass mulch. The length of fruit of bitter gourd showed significant variation ($P<0.05$) for application of each mulch over no mulch and between themselves. The minimum lengths of fruit of plant are also found under the control plot of the both years. The variations of length of fruit of bitter gourd in different year were not significant at each of the treatments. Fruit length of bitter gourd was better in 2nd (2012) year. The result of the diameter of fruit of the bitter gourd crop as influence by various applied treatments is shows in the (Table 3 and Fig 2). The significantly highest ($P<0.05$) diameter of fruit of bitter gourd crop were observed in jute, live mulch and coco coir mulch both the year. Similarly diameter of fruit varies with the variation of treatments and values are obtained as 4.05 cm, 4.00 cm, 3.90 cm, 3.25 cm and 3.00 cm in respectively of in pitcher pot irrigation + jute fibre mulch, pitcher pot irrigation + live mulch, pitcher pot irrigation + coco coir mulch, pitcher pot irrigation + babui grass mulch and pitcher pot irrigation + no mulch. The results reveal that response of diameter of fruit of the bitter gourd crop over control due to each treatment were 1.05 cm (35%), 1 (33.33%), 0.90 cm (30%) and 0.25 cm (8.33%) respectively in pitcher pot irrigation + jute fibre mulch, pitcher pot irrigation + live mulch, pitcher pot irrigation + coco coir mulch and pitcher pot irrigation + babui grass mulch. The diameter of fruit of bitter gourd showed significant variation ($P<0.05$) for application of each types of mulches over no mulch and between themselves.

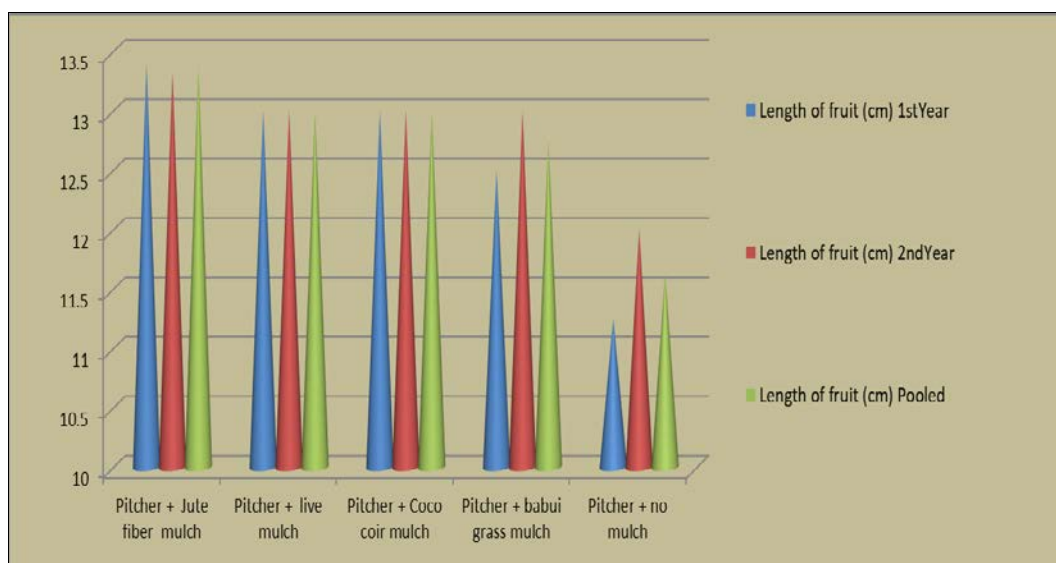


Fig 1: Length of bitter gourd under different treatments

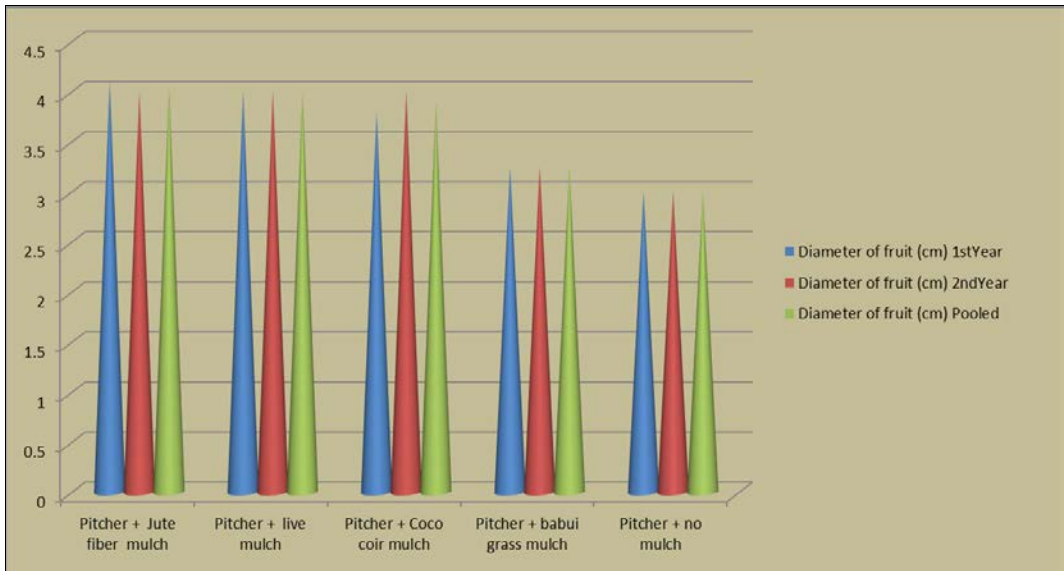


Fig 2: Diameter of bitter gourd under different treatments

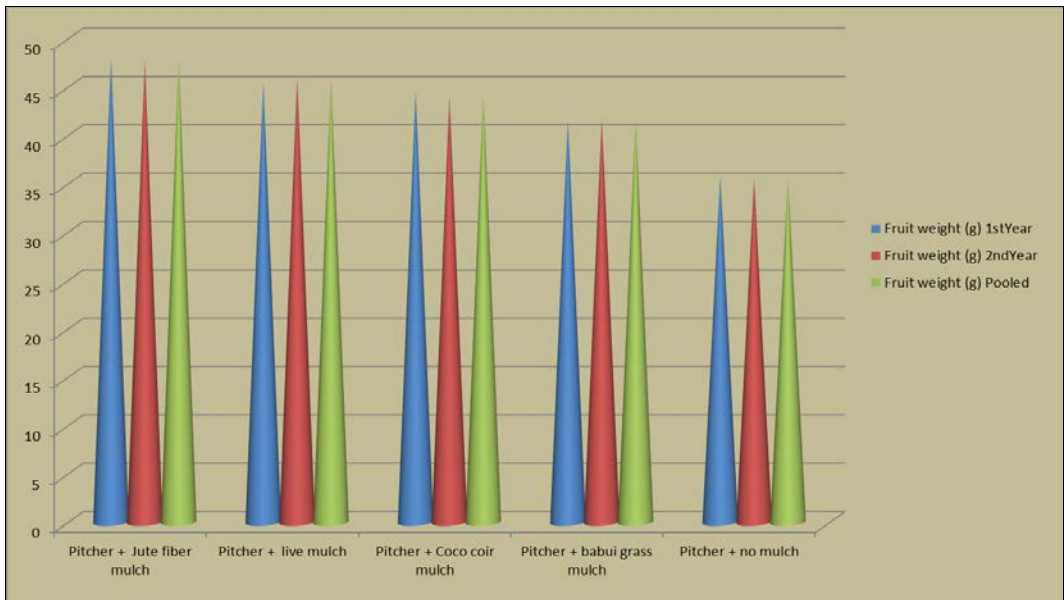


Fig 3: Fruit weight of bitter gourd under different treatments

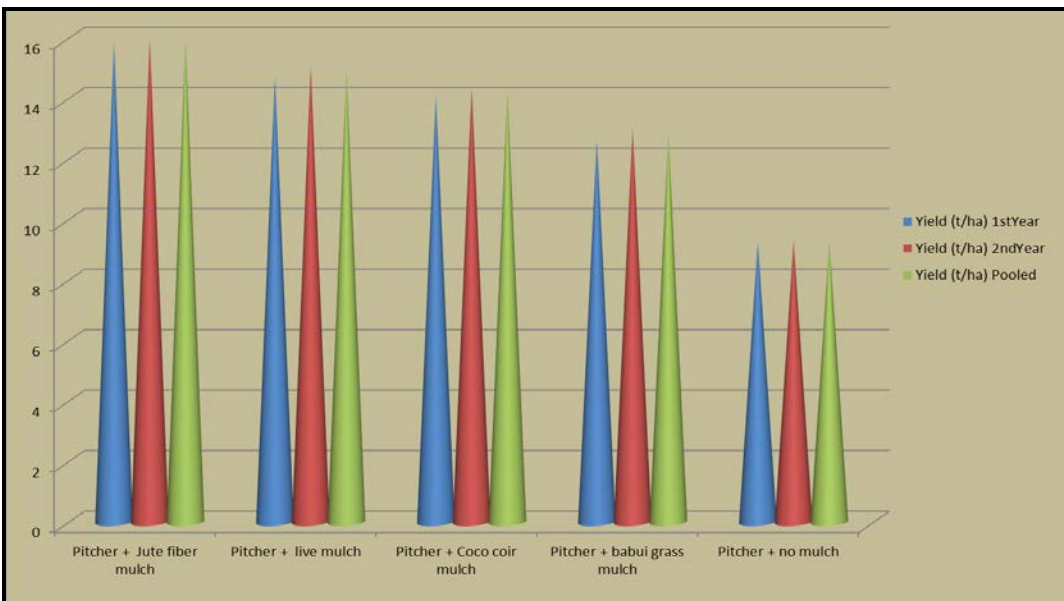


Fig 4: Fruit weight of bitter gourd under different treatments



Fig 5: Bitter gourd under pitcher irrigation different treatments

Conclusion

Therefore, it may be concluded that among the various treatments pitcher irrigation with jute mulch found most efficient to keep the soil in favourable condition improvement of crop production.

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