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Effect of Pitcher Pot Irrigation with Mulching on Cowpea (*Vigna unguiculata*) Production in an *Alfisol* India

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ABSTRACT

Mulching with pitcher irrigation is a modern way to give irrigation along with moisture conservation which increase the water use efficiency and check evapotranspiration as a result organic matter content and decomposition along with population of microorganism increase. The benefit of pitcher pot irrigation comes in several ways to soil. It improve the soil water holding capacity, soil texture and structure, soil stability and aggregation, control soil erosion and reduce formation of rust. Pitcher irrigation is a technique of alternative way to give drip irrigation and manage water in sustainable approach water management to fulfill water requirement, where water irrigation water and low rainfall are major problem for crop production. The efficiency of pitcher irrigation is higher than other system for provide irrigation water in crop production, since its deliver water in plant root zone rather than broader area. The experiment have total five different treatments,Treatment1 – Jute fiber with Pitcher pot irrigation, Treatment 2 – Live mulch with pitcher pot irrigation, Treatment 3- Coco coir with pitcher pot irrigation, Treatment 4- Babui grasses with pitcher pot irrigation and Treatment 5 – Without mulch (Control) with pitcher pot irrigation. After completed research work two years, result found yield of cow pea improved by combination of pitcher irrigation and mulching. The following experiment is covering SDG2 and SDG15 points under sustainable-development (FAO 2021).

Keywords Mulching, Pitcher irrigation, Cowpea, *Alfisol*.

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INTRODUCTION

Irrigation is one of the main especial input require for grow crop and for that require high water supply (Adhikary *el al.* 2020). Mixing the mulch with pitcher irrigation in soil; improves water use efficiency by

measuring of evaporation as well as soil moisture conserves, which is help to increase microbial activities as a result decomposition of organic matter and humans residue content in soil (Adhikary and Pal 2020). The technique improved soil density, porosity, aggregation, suitability, reduces crust formation which is help to protect the soil and controls soil erosion (Pal *et al.* 2020). Also this technique improves water holding capacity, maintain soil temperature and control salinity. Weed control also be reduce by added mulch residue, which reducing labor costs for weeding. The current experiment learn us to increase of biomass production and sustain nutrient balance in soil with live mulch *in situ* for grow vegetable and legume crop in crop rotation (Pine *et al*. 2013, Pal *et al.* 2020 and Adhikari *et al.* 2016).

Pitcher pot irrigation is an olden irrigation technique, originated in Northern Africa and Iran (Stein 1998 and Pal *et al.* 2020). The method of pitcher irrigation also found in book written around 2000 years ago in China (Sheng 1974). Pitcher irrigation method has been found very efficient method of irrigation in watermelons in the country like India and Pakistan (Umalaxmi *et al.* 2017). Similar results are also reported by Mahata *et al.* (2021), 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. It is a traditional, alternative and advance system to provide drip irrigation where water scarcity becomes a major problem for crop production (Adhikary *et al.* 2020).

Pitcher irrigation is a self-regulative, low cost and eco technique of irrigation having a high potential of energy saving, water saves and very much efficiency in orchard planting (Kefa *et al.* 2013). 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. The seepage rate is direct 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 many factors affected the efficiency of pitcher of irrigation like soil type, weed competition, site microclimate, soil structure, soil fertility and plant species. The mulching with pitcher pot irrigation system saves around 50–70 percentage of water compare than conventional method or irrigation (Reddy and *et al.* 2021). This system important for those who want to conserve the water (Kefa *et al.* 2013). Irrigation through this process stable soil moisture which empowers crops to grow in saline soils also. The method is suitable for using saline waters in pitcher but not applicable in conventional irrigation (Pine *et al*. 2013, Pal *et al.* 2020 and Adhikari *et al*. 2016).

Alfisol constitutes an area of 13.1% globally twelve soil order established in soil taxonomy. These soils are arable with low moisture suitable for at least three sequential month of the growing season. This soil order containing soil typically well-developed, conflicting soil horizons, less in calcium and magnesium carbonate but enriched aluminum and iron based minerals. Under *Alfisols* the area cover in India at least 33% of soil under arid and semi-arid region (Adhikary and Pal 2019) and having soil low infiltration rates on these highly friable soils are mainly caused by a surface crust. Surface crust is an process where effect of raindrops physical disintegration soil from aggregates and subsequent dispersion and compaction occurred (Mahata *et al.* 2021) which accelerate in soil having low organic matter and low soil strength under saturated condition, poor aggregation lead to loss of surface roughness, slumping and high bulk density. Effective soil management practices are the essential step to increase productivity through improvement infiltration and, thereby, increase availability for use by crops in *Alfisols*. In a long term experiment at ICRISAT various combination of management practices involving tillage and organic amendments to protect and improve soil structure of both surface and subsurface layers (Adhikary *et al.* 2020).

MATERIALS AND METHODS

The experiment was carried out in farmer's field in Paschim Medinipur, Garbeta II, Amlasuli, is 22051'07.06'' North Latitude and 870 10'52.58'' East Longitude, altitude 20 m above mean sea level. Area under subtropical hot and humid climate under rain shadow hilly area. The average yearly

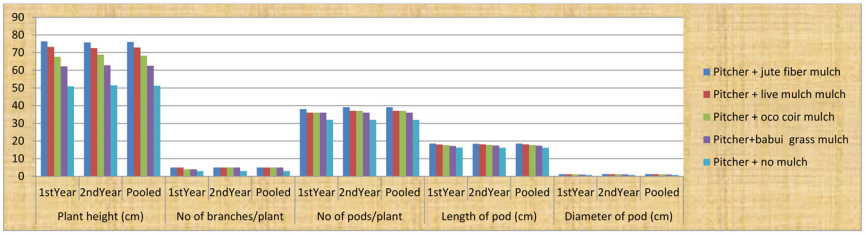

Fig. 1. Effect of pitcher pot irrigation and mulching on physiological parameter of cowpea.

rainfall received 1247 mm received in 75 rainy days .Cowpea (*Vigna unguiculata*) Duration : Last week of November to first week of March, Design : Randomized Block Design, Replication : 4. Treatments are T_1 - Pitcher pot irrigation with jute fiber mulch, T_2 - Pitcher pot irrigation with live mulch (black gram), T_3- Pitcher pot irrigation with coco coir mulch, T_4- Pitcher pot irrigation with babui grass mulch and T_5 - Pitcher pot irrigation with no mulch (Control). The single pitcher irrigation with mulch content placed between four plants and each pot capacity is 10 liters. All four mulching materials spaded in field after transplantation of vegetable seedling @ 5 ton ha^{-1}.

RESULTS AND DISCUSSION

The result of the effect of various mulching combination on the plant height of cowpea crop are summarized (Table 1 and Fig. 1). It reveal that the plant height of cowpea crop growing period varies significantly with the variation in the different treatment practices in both year 2011 and 2012. The results found that plant height initiation were recorded as 76.06, 72.92, 68.24, 62.54 and 51.21 cm respectively in pitcher pot irrigation + jute fiber 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 plant height of cowpea over pitcher pot irrigation + no mulch due to each treatment were 24.85(48.52%), 21.71(42.39%), 17.03(33.25%), 11.33(22.12%) over control. The results found that number of branch (Table 1 and Fig. 1) initiation pool data were recorded as 5.17, 4.95, 4.64, 4.44 and 3.16 respectively. The results reveals that response of number of branch of the cowpea crop

Table 1. Effect of pitcher pot irrigation and mulching on physiological parameter of cowpea.

Treatment	Plant height (cm)			No. of branches/ plant			No. of pods/plant			Length of pod (cm)			Diameter of pod (cm)		
	1st year	2nd year	Pooled	1st year	2nd year	Pooled	1st year	2nd year	Pooled	1st year	2nd year	Pooled	1st year	2nd year	Pooled
Pitcher + jute fiber mulch	76.36	75.76	76.06	5.00	5.00	5.00	38.00	39.00	39.00	18.53	18.50	18.51	1.23	1.28	1.25
Pitcher + live mulch mulch	73.24	72.60	72.92	5.00	5.00	5.00	36.00	37.00	37.00	18.05	18.13	18.09	1.18	1.20	1.19
Pitcher + oco coir mulch	67.63	68.85	68.24	4.00	5.00	5.00	36.00	37.00	37.00	17.65	17.78	17.71	1.10	1.15	1.13
Pitcher+babui grass mulch	62.22	62.87	62.54	4.00	5.00	5.00	36.00	36.00	36.00	17.23	17.43	17.33	1.05	1.08	1.06
Pitcher + no mulch	50.91	51.51	51.21	3.00	3.00	3.00	32.00	32.00	32.00	16.23	16.20	16.21	0.75	0.78	0.76
Total	66.07	66.32	66.19	4.20	4.60	4.60	35.60	36.20	36.20	17.54	17.61	17.57	1.06	1.10	1.08
SE (m)	0.412	0.219	0.23	0.022	0.027	0.02	0.081	0.106	0.07	0.057	0.027	0.03	0.022	0.022	0.02
LSD (0.05)	1.270	0.675	0.68	0.069	0.084	0.06	0.248	0.327	0.20	0.176	0.084	0.09	0.069	0.069	0.05
Year *	SE (m)		0.33			0.03			0.09			0.04			0.02
Treatment	LSD (0.05)		0.96			0.08			NS			NS			NS

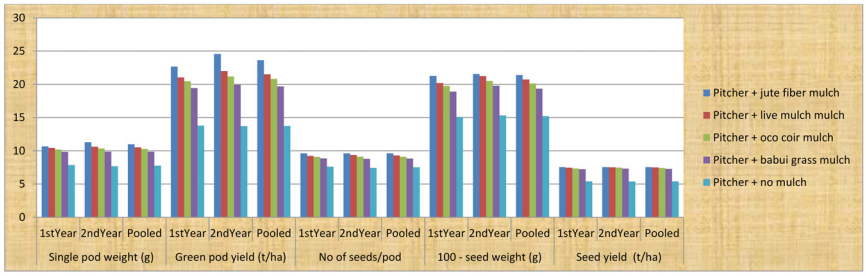

Fig. 2. Effect of pitcher pot irrigation and mulching on yield and yield attributes of cowpea.

over pitcher pot irrigation + no mulch due to each treatment were 2.01 (63.60%), 1.79 (56.64%), 1.48 (46.83%), 1.28 (40.50%) respectively in pitcher pot irrigation + jute fiber mulch, pitcher pot irrigation + live mulch, pitcher pot irrigation + coco coir mulch and pitcher pot irrigation + babui grass fiber mulch. The results of length of pod cowpea (Table 1 and Fig. 1) were observed as 18.51, 18.09, 17.71, 17.33 and 16.21 cm. The minimum lengths of pod of cowpea are also found under the control plot in the both year. Similarly diameter of pod cowpea crop (Table 1 and Fig. 1) varies with the variation of treatments and values are obtained as 1.25, 1.19, 1.13, 1.06 and 0.76 cm in respectively for the treatment of jute pitcher pot irrigation + jute fiber 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 effect of pooled data for 2011 and 2012 also resembles with findings (Fig.1). Highest ($P<0.05$) diameter of pod was recorded in jute fiber geotextile.

The this study, it was found that application of various types of mulching materials with pitcher pot seed yield of cow pea grown in 2011 and 2012 showed variation. The seed yields of cowpea (Table 2 and Fig. 2) were recorded as 7.55 (pitcher pot irrigation + jute fiber mulch, 7.49 (pitcher pot irrigation + live mulch), 7.41 (pitcher pot irrigation + coco coir mulch), 7.27 (pitcher pot irrigation + babui grass mulch) and 5.39 (Control) tons ha^{-1}. However, result showed the significant variation in grain yield of cowpea due to application different type of treatments in both years. Significantly highest ($P < 0.05$) seed yield was recorded 2.16 (40.07%), 2.10 (38.96%), 2.02 (37.48%) and 1.88 tons ha^{-1} (34.88%) over control significantly increased. The data observed that variation of cowpea seed yield by different treatment application every year and yield performance is better in first year in all treatments. Also this experiment the green pod yield of cowpea (Table 2 and Fig. 2) was recorded as 23.61 (Jute fiber with pitcher), 21.52 (Live mulch with pitcher), 20.83 (Coco Coir with pitcher), 19.68 (*Babui drasses* with pitcher) and 13.73 tons ha^{-1} (No mulch with pitcher) and significantly highest ($P<0.05$) green pod yield was recorded in pitcher pot irrigation + jute fiber mulch.

The numbers of pod/plant of cowpea (Table 2 and Fig. 2) were recorded as 38.72 (Jute fiber with pitcher), 36.81 (Live mulch with pitcher), 36.52 (Coco Coir with pitcher), 35.96 (*Babui drasses* with pitcher) and 31.87 (Control) respectively and significantly highest ($P<0.05$) green pod yield was recorded in pitcher pot irrigation + jute fiber mulch Response of numbers of pod/plant over control due to each treatment were 6.85 (21.49%), 4.94 (15.50%), 4.65(14.59%) and 4.09(12.83%) over control.

The current study, it was noted that number of seed / pod of the cowpea crop as influence by various applied treatments are shows in the (Table 2 and Fig. 2). Number of seed / pod varies with the variation of treatments and values are obtained as 9.63 (Jute fiber with pitcher), 9.30 (Live mulch with pitcher), 9.10 (Coco Coir with pitcher), 8.83 (*Babui drasses* with pitcher) and 7.51 (Control).

The results of single pod weight cowpea (Table 2 and Fig. 2) were observed as 10.98, 10.53, 10.28,

Table 2. Effect of pitcher pot irrigation and mulching on yield and yield attributes of cowpea.

Treatment	Single pod weight (g)			Green pod yield (t/ha)			No of seeds/pod			100 seed weight (g)			Seed yield (t/ha)		
	1st year	2nd year	Pooled	1st year	2nd year	Pooled	1st year	2nd year	Pooled	1st year	2nd year	Pooled	1st year	2nd year	Pooled
Pitcher + jute fiber mulch	10.66	11.30	10.98	22.66	24.55	23.61	9.63	9.63	9.63	21.28	21.55	21.41	7.54	7.55	7.55
Pitcher + live mulch mulch	10.45	10.62	10.53	21.04	22.00	21.52	9.23	9.38	9.30	20.20	21.25	20.73	7.46	7.52	7.49
Pitcher + oco coir mulch	10.19	10.36	10.28	20.47	21.19	20.83	9.08	9.13	9.10	19.75	20.51	20.13	7.34	7.47	7.41
Pitcher + babui grass mulch	9.85	9.87	9.86	19.43	19.94	19.68	8.85	8.80	8.83	18.90	19.79	19.35	7.22	7.33	7.27
Pitcher + no mulch	7.85	7.68	7.76	13.76	13.70	13.73	7.60	7.43	7.51	15.08	15.30	15.19	5.41	5.37	5.39
Total	9.80	9.96	9.88	19.47	20.28	19.87	8.88	8.87	8.87	19.04	19.68	19.36	6.99	7.05	7.02
SE (m)	0.035	0.032	0.02	0.087	0.065	0.05	0.065	0.035	0.04	0.175	0.096	0.00	0.027	0.000	0.02
LSD (0.05)	0.109	0.097	0.07	0.267	0.201	0.16	0.201	0.109	0.11	0.538	0.296	0.00	0.084	0.000	0.05
Year * Treatment	SE (m)		0.03			0.08			0.05			0.14			0.02
	LSD (0.05)		0.09			0.22			NS			0.41			0.07

9.86 and 7.76 g respectively. Minimum single pod weights of cowpea were recorded in control plot. Response single pod weight over pitcher pot irrigation + no mulch due to each treatment were 3.22 (41.49), 2.77 (35.70), 2.52 (32.47) and 2.10 (27.06 %). The 100 seed weight of cowpea were recorded as 21.41 g, 20.73 g, 20.13 g, 19.35 g and 15.19 g respectively in pitcher pot irrigation + jute fiber 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 effect of pooled data for 2011 and 2012 also resembles with findings significantly highest ($P<0.05$) 100 seed weight of cowpea were recorded in jute fiber mulch.

CONCLUSION

Therefore, it may be concluded that various mulching with pitcher pot irrigation to keep the soil in favorable condition towards improving physical and chemical condition, increasing water as well as nutrients availability in soil thus influence improvement of crop production. Jute fiber mulch with pitcher pot irrigation proves much superior for moisture use efficiency and benefit cost ratio as well as productivity of cowpea.

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