



On-farm Evaluation of Furrow Irrigated Raised Bed System with Plastic Mulch for Brinjal Crop

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ABSTRACT

An on-farm experiment was conducted on farmers' field in two villages of Unnao district, Uttar Pradesh to evaluate the effectiveness of mulched and non-mulched furrow irrigated raised bed (FIRB) system over farmers' practice of check basin irrigation for brinjal crop. The system performance was assessed in terms of crop physiological parameters, water saving, yield, water productivity and cost of cultivation. Mulch significantly affected the physiological parameters of crop like plant height, number of branches, girth, root depth, leaf area and fruit weight. Results revealed that the water savings under furrow irrigated raised bed system without mulch (T2) and with mulch (T3) was 167.7 mm (31.2 %) and 237.0 mm (44.1 %), respectively, as compared to farmers' practice (T1). Significantly higher brinjal yield (21.29 t.ha⁻¹) was observed in T3, which was 26.7 % higher over T1. Higher yield and comparatively lesser application of irrigation water resulted in significantly high water productivity (88.49 kg.ha-mm⁻¹) in T3 as compared to T1 (31.34 kg.ha-mm⁻¹). The average benefit-cost ratio (BCR) for the treatments T1, T2, and T3 were 2.21, 2.58 and 2.62, respectively. Furrow irrigated raised bed cultivation of brinjal with black plastic mulch is recommended to the farmers of central Uttar Pradesh to achieve twin objectives of improved crop yields and increased water productivity.

Effective and judicious management of irrigation as well as gaining higher crop yield are important aspects for water conservation and doubling the farmer's income. Most of the farmers practice flood irrigation (check basin and border) system to irrigate the crops in the Unnao district, Uttar Pradesh. Further due to limited canals network and poor surface irrigation infrastructure in the Unnao district, farmers use more tube wells to extract groundwater for irrigation. As per recent Central Ground Water Board report (CGWB, 2019), out of the total 6881 assessment units (Blocks/Mandals/Talukas/Firkas) in the country, 1186 units (17 %) in various States have been categorized as 'Over-Exploited', indicating groundwater extraction exceeding the annually replenishable groundwater recharge; and 313 units (5 %) are 'Critical' where stage of groundwater extraction is between 90-100 %. The over-exploited areas are mostly concentrated in the north-western part of the country including

parts of Punjab, Haryana, Delhi and Western Uttar Pradesh; the western part of the country, particularly in parts of Rajasthan and Gujarat; and the southern part of peninsular India including parts of Karnataka, Andhra Pradesh, Telangana and Tamil Nadu. This calls for introduction of water saving technologies like minimum soil disturbance (zero tillage); diverse crop rotations and cover crops; continuous plant residue cover (mulching) and micro-irrigation for sustainable crop production. Although, groundwater resources in most of the regions of Uttar Pradesh are shrinking, farmers still adopt flood irrigation system because of its ease in design and operation, low cost and energy requirement as compared to the pressurized irrigation methods. In the absence of canals network and poor surface irrigation infrastructure, farmers' are left with two hard options for agriculture; first they re-bore the well up to 60 meter which may cost about ₹ 1.5 lakh plus electricity installation charges, and secondly they

widen the well and lower the pump as near as possible to the water-bearing strata. Most of the farmers install their pump up to 15 meter deep below the ground level for fulfilling the irrigation requirements of the crops. The proper management of groundwater, as well as the surface water, is necessary for long-term sustainability of the water resources for both agriculture and domestic purposes.

Conservation of soil moisture is the major advantage of mulching on cultivated soil with crop residue, plastic sheet, or stubble (Mulumba and Lal, 2008; Li *et al.* (2013). Mulching provides favorable micro-climate that facilitates retention of soil moisture, improves physical, chemical and biological properties of soil and also helps to control temperature fluctuations, and thereby resulting in better plant growth and higher crop yield (Bhardwaj, 2013). Li *et al.* (2013) showed that plastic mulching could work as a barrier against evaporation losses, and thus enhance the soil moisture storage capacity and improve the biological activities. Mulching with plastic film improved soil moisture, increased soil temperature, root and shoot biomass and leaf area development of sunflower (Agele *et al.*, 2010). In addition to soil water conservation, Mulumba and Lal (2008) reported that by reduction of evaporation from the soil surface, plastic mulching increases the crop growth by increasing water availability to plant. Furthermore, black plastic mulching controls the weeds, and increase the availability of nutrient to plants which contribute to higher crop yield (Subrahmaniyan *et al.*, 2008). Many scientists (Moreno and Moreno, 2008; Ban *et al.*, 2009; Mamkagh, 2009; Berihun, 2011; Bhatt *et al.*, 2011; Hatami *et al.*, 2012; Kumar and Lal, 2012) reported higher crop yields under black plastic mulch over un-mulched conditions. Earliness of harvest, and improved yield and quality of the vegetable crop by the use of plastic mulch has also been reported by researchers (Raina *et al.*, 1999; Bhardwaj, 2013). The 25-micron thick plastic mulch was reported to provide higher yield of grafted brinjal in comparison to un-mulched conditions (Rajasekar *et al.*, 2017).

Surface irrigation, in which water flows by gravity onto the field, is the most commonly used irrigation method in the Unnao district of Uttar Pradesh. The advantage of surface irrigation (basin, furrow and border irrigation) is that it neither involve operation of sophisticated equipment nor much capital investment, making it more suitable for small farmers (Orlina and Schaldach, 2018). This practice is most appropriate for soils with good water holding capacity and internal

drainage (Putnam, 2012). Furrow irrigation, in spite of low water application efficiency, is a simple and ready-to-adopt irrigation method by farmers as compared to the pressurized irrigation (Ampas and Baltas, 2009). Experimental results showed that furrow irrigated un-mulched plots resulted in higher crop water use due to high evapotranspiration losses, compared to the mulched plots (Ramalan and Nwokeocha, 2000). Maurya *et al.* (2018) reported that use of black plastic mulch in tomato crop with furrow irrigation system significantly increased the water productivity than that of border irrigation, and concluded that plastic mulching with furrow irrigation is cost-effective measure to conserve the soil moisture than pressurized irrigation in Unnao district of Uttar Pradesh, and farmers benefited with higher crop production.

Brinjal (*Solanum melongena* L) is an important crop of the Unnao district, and most farmers grow the crop under flood irrigation methods. Review of literature suggested that, although polythene mulching has been found to be effective approach to improve water productivity, its effectiveness in combination with furrow irrigation is yet to be investigated for brinjal crop. The objective of the present study was to quantify the water saving and water productivity of brinjal crop under plastic mulched furrow irrigated raised bed system, and compare the results with farmer practice of conventional check basin system. The study also focused on evaluating performance and cost-effectiveness of this system for brinjal cultivation.

MATERIALS AND METHOD

Study Area

The Unnao district is situated nearly to the center of Uttar Pradesh and occupies an area of 4558 km². It lies on both sides of river Gomti between latitude of 26° and 26° 40' N and longitude of 81° 41' and 82° 41' E. It is a part of Gangetic alluvial tract and the surface is generally flat except by side of river Gomti and its tributaries. The climate of this district is characterized by a hot summer and a pleasant cold season. May is generally the hottest month with the mean daily maximum at 40.6°C and the mean daily minimum at 25.5°C whereas January is usually the coldest month with the mean daily maximum at 22.9°C and mean daily minimum at 8.6°C. The average annual rainfall is 1005 mm and about 89 % of the annual rainfall is received during the southwest monsoon months of June to September. The economy of the district is pivoted around agriculture with nearly 69.6 % of the

workers are engaged in agriculture related activities. The district has 70.9 % of cultivable area to total area and the percentage of irrigated area to total cultivable area is 92.9 % in the district (Census of India, 2011).

The trail was laid out at Pilakhna ($26^{\circ}50'36.8''N$ & $80^{\circ}38'53.3''E$) and Buxikhera ($26^{\circ}50'27.3''N$ & $80^{\circ}41'18.1''E$) villages of Hasanganj block of Unnao district (Fig. 1). Major crops grown in these villages are seasonal vegetables like tomato, brinjal, cauliflower, bottle and sponge gourd, leaf and root vegetables. Groundwater is the main source of irrigation in these villages which contributed about 71 % of total cultivable area. Farmer's dependency on groundwater irrigation resulted in decline water table level in the block with a rate of 0.1215 m.yr^{-1} (Singh, 2013). Farmers were trained at Krishi Vigyan Kendra, Unnao to grow vegetables using mulching, and four farmers were selected from each village to conduct the experiment. The experiment was conducted during Rabi season spanning from October, 2017 to March, 2018. The selected villages are less than 5 km apart, and there are no appreciable differences in the climatic conditions. The soils in the villages are clay loam and sodic in nature. The physical and chemical properties of the soil of two villages were tested at Krishi Vigyan Kendra, Unnao, and are given in Table 1. Very light shower (8 mm) of rainfall was recorded during the crop period. The maximum and minimum temperature was



Source: Google Map

Fig. 1: Geographical map of Unnao district with trail set-up village location

Table 1. Range of physical and chemical properties of soils across experimental fields in two villages

Sl.No.	Soil parameter	Range
1.	Soil pH	8.6-9.3
2.	pH of irrigation water	7.9-8.1
3.	Soil EC, mmhos.cm ⁻¹	0.27-0.35
4.	Water EC, mmhos.cm ⁻¹	0.70-0.77
5.	Organic carbon, %	0.14-0.24
6.	Available N, kg.ha ⁻¹	195-222
7.	Available P, kg.ha ⁻¹	12-16
8.	Available K, kg.ha ⁻¹	248-282
9.	Exchangeable Na, %	30-42
10.	Soil Nature	Sodic
11.	Bulk density, kg.m ⁻³	1510-1560
12.	Soil texture class	Clay loam

recorded as $47^{\circ}C$ and $7^{\circ}C$, respectively, during the crop period (AccuWeather Inc., 2018).

Experimental Treatments

Three treatments with four replications each at Pilakhna and Buxikhera villages were conducted at farmers' field. The treatments included farmer's practice of check basin irrigation as a control (T1), furrow irrigated raised bed (FIRB) (T2), and furrow irrigated raised bed with plastic mulch (T3). The area under each treatment (T1, T2, and T3) was $30 \text{ m} \times 20 \text{ m}$. Groundwater was used for irrigation. The bed width of raised bed was 1.10-1.05 m, and 'U' shaped furrow was initially selected with 420-500 mm top width and 70-80 mm deep (Fig. 2). The slope in each 20 meter furrow was in between 0.14 % to 0.22 % at the time of land preparation.

Black plastic film of 25 micron thickness and 1.20 m in width was used as mulching material. Irrigation was

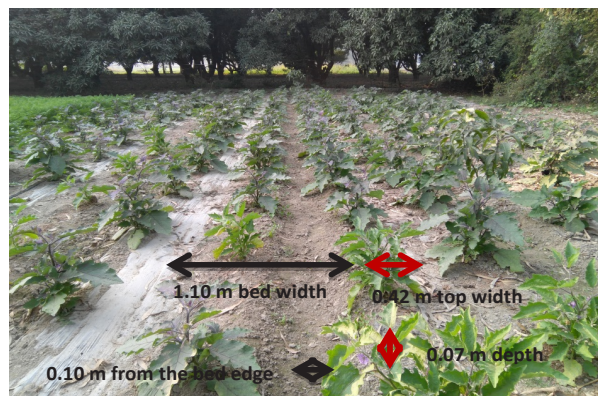


Fig. 2: Brinjal plant growth and development in treatment T3

applied in the furrow till water front advanced to the tail end of the furrows. The irrigation was scheduled on the basis of farmer's inspection of soil moisture and crop condition, and 7-8 irrigations were applied in all the treatments. The discharge of pump and duration of irrigation were recorded for each irrigation event to work out the depth of irrigation water applied during the cropping season. The duration of irrigation in treatment T1 was based on farmers' practice of maintaining the average depth of 101.6 mm at the furthest point of the plot from water inflow point.

Fertilizer and manure were broadcasted on beds in treatments T2 and T3, whereas in T1 it was broadcasted onto the plot. Cost of nursery growing and application of insecticide remained the same for all treatments.

Brinjal seedlings (cv Navkiran) were raised in the nursery at the farm of Krishi Vigyan Kendra, Unnao with the recommended seed rate of 125 g.ha⁻¹. Recommended dose of FYM (20-25 t.ha⁻¹) incorporated in treatments (Saravaiya *et al.*, 2010). Seedlings were transplanted after 30-35 days of sowing. Row-to-row and plant-to-plant distance of 900 mm and 450 mm, respectively, was adopted as per recommendations. Brinjal seedlings were transplanted 100 mm inside the bed edge in T2 and T3 (Fig. 2). Before transplanting the seedlings, each plot was ploughed to fine tilth by rotavator. The experimental plots in T1 were dressed with basal dose of FYM at the rate of 25 t.ha⁻¹, and 20 t.ha⁻¹ was applied in treatments T2 and T3 plots. Azospirillum and Phosphobacteria were mixed in FYM at the rate with 2 kg.ha⁻¹ each before applying to the field (Reddy, 2015). The basal dose of fertilizer was applied to the soil at the rate of 130 kg.ha⁻¹ in T1 and 100 kg.ha⁻¹ in T2 and T3. Nitrogen (N) and Potash (K) each @ 150 kg.ha⁻¹ were applied in three equal splits at 30, 45 and 60 days after planting. Broadcasting of manure and fertilizer in T1 increases the requirement of FYM, urea, and DAP, thereby increasing the input cost of fertilizers. For treatment T2 and T3, the fertilizers were broadcasted on beds, leading to reduced fertilizer requirement and expenditure. FYM was broadcasted over the bed in treatment T3 before covering with plastic. Wilt disease and blackleg caused by *Phomopsis* blight was spotted in all the treatment (Fig. 3) and controlled by spraying of Mancozeb 75 % WP at the rate of 2.5 g.l⁻¹ 55 days after transplanting.

Evaluation of Parameters

Irrigation water application and water productivity

Discharge of water was estimated by the volume-



Fig. 3: Weed infestation and brinjal plant growth in plastic mulching treatment T1, T2 and T3

duration method. Pumping sets were installed at the farmer's field, and pumped water was filled into the sink/tank and time required to fill the sink was noted. The volume of water collected in the sink was measured with 5 liter bucket. This measurement of volume of water and the respective time required to fill the sink is repeated four times for getting accurate discharge. The pump discharge was computed as the ratio of measured volume of water and time required to fill the sink. Depth of irrigation was calculated by dividing total water volume used during the crop period with the area under each treatment.

The major parameters considered to determine the effectiveness of mulching and furrow irrigation were depth of irrigation, yield, water productivity (WP), and benefit-cost ratio (BCR). Different parameter recorded for each treatment was integrated to the hectare level for the final calculation. Brinjal fruits were plucked out and the weight of the fruits was recorded after each plucking. Yield was integrated with respect to the hectare to determine the crop yield in kg.ha⁻¹. The crop yield was divided with volume of irrigation to evaluate the water productivity (WP) in kg.ha-mm⁻¹.

Physiological crop parameters

The physiological crop parameters like plant height, girth, number of branches, number of leaves and root length were recorded for five randomly selected plants in each treatment after 55 days of transplanting. Plant height, root length and girth were evaluated with measuring tape. Leaf area was calculated with graphical method by using graph paper of 100 mm² grid area. Randomly selected brinjal fruits were weighed and averaged for determining its weight for each treatment

Cost Estimation

For adaptation of any agricultural technique, the cost is the main perspective of farmer. The total cost of cultivation included the costs of field preparation for the nursery, seedling transplantation, plastic mulching, fertilizer, insecticides, irrigation, intercultural operation, harvesting and other miscellaneous costs. Benefit-cost ratio (BCR) was calculated by dividing the gross income with the involved cost of cultivation.

Data Analysis

Physiological parameters, irrigation depth, yield and water productivity were analyzed statistically with Microsoft Excel. One factor-Analysis of Variance (ANOVA) was conducted to find the significant differences among the means with the level of significance at $p < 0.05$.

RESULT AND DISCUSSION

Physiological Parameters

Plastic mulching with furrow irrigated raised bed practice significantly influenced the physiological parameters of brinjal (Table 2). The plant height, girth, number of branches, number of leaves, leaf area, root depth per plant and fruit weight in treatment T3 were 580 mm, 540 mm, 6, 37, 22900 mm², 250 mm and 650 g, respectively. Figures 2 and 3 depict the effect of black plastic mulching on physiological parameters of brinjal. Weed infestation retarded the growth of plants in treatments T1 and T2. Statistical analysis revealed that values of physiographical parameters under treatment T3 were significantly higher than those observed under treatments T1 and T2. Further, furrow irrigation led to significantly higher leaf area in treatment T2 than those of T1 under check basin irrigation. The values of differences in plant physiological parameters observed under treatments T1 and T2 were statistically non-

significant, implying that mere furrow irrigation doesn't influence the physiological parameters of the crop except leaf area but the combination of furrow irrigation with mulching is effective in achieving better plant growth. As compared to non-mulched treatments (T1 and T2), the plant height in mulched treatments (T3) was significantly higher. The plant height in mulched treatments (T3) was found to be doubled as compared to the treatment T1. These findings corroborate well with the findings of Chawla (2006). As reported by Agele *et al.* (2010) and Bhardwaj (2013), improved soil moisture and soil temperature under mulched treatments leads to better root development which in-turn enhances the development of shoot biomass.

Irrigation Water Use

All three treatments were given 7 to 8 irrigations. The plot-wise depth of irrigation water applied in each treatment is depicted in Fig. 4. Low duration irrigation was given at the initial stages of the crop (light irrigation). Check basin method of irrigation (T1) required more irrigation time i.e. 30-40 minute more than that of furrow irrigated raised bed (T2 and T3). The average irrigation depths during the crop growth period in each treatment are given in Table 3. Highest average irrigation depth was required in treatment T1 (537.5 mm), whereas treatment T3 required lowest (300.5 mm) among the treatments. The average irrigation depth in treatment T2 was 369.8 mm.

As compared to farmers practice, the black plastic mulch with furrow irrigation saved 44.1 % water, while non-mulched furrow saved 31.2 % irrigation water (Table 3). Presence of mulch reduces the evaporation from the wet soil surface, and effective to retain the soil moisture as reported by many scientists (Mahadeen, 2014; Ramakrishna *et al.*, 2006; Ban *et al.*, 2009; Wang *et al.*, 2009; Kumar and Lal, 2012).

Table 2. Effect of mulching on physiological parameters of brinjal crop

Sl.No.	Physiological parameter	T ₁	T ₂	T ₃	Critical difference (CD)
1.	Plant height, mm	290 ^b ±1.24	300 ^b ±1.28	580 ^a ±1.66	4.26
2.	Trunk girth, mm	30 ^b ±1.60	30 ^b ±1.72	54 ^a ±2.50	6.00
3.	Number of branches per plant	3 ^b ±0.23	3 ^b ±0.23	6 ^a ±0.38	0.86
4.	Number of leaves per plant	23 ^b ±1.48	23 ^b ±1.76	37 ^a ±0.70	3.03
5.	Leaf area, mm ²	13200 ^b ±9.11	14700 ^b ±6.57	22900 ^a ±8.06	5.02
6.	Root depth, mm	150 ^b ±0.30	150 ^b ±0.55	250 ^a ±0.86	1.86
7.	Fruit weight, g	325 ^b ±25	369 ^b ±28.25	650 ^a ±31.34	85.76

*means with different superscripts in a row are significantly different at $p < 0.05$

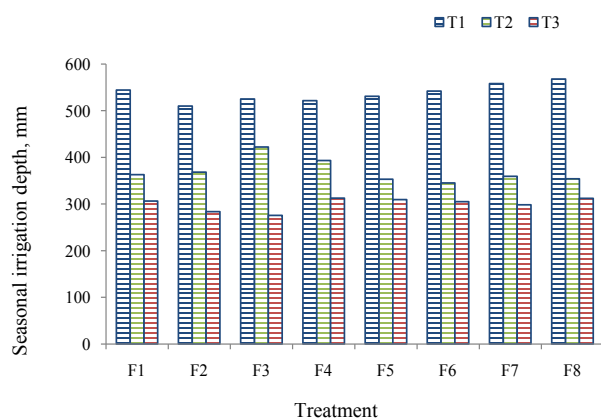


Fig. 4: Plot-wise depth of irrigation water applied under different treatments

Yield

Highest yield of brinjal was recorded in treatment T3, and lowest in treatment T1, while there was marginally higher yield in treatment T2 over T1 (Table 3). The average yield of brinjal in treatments T1, T2, and T3 were 16.81, 18.21 and 21.29 t.ha⁻¹, respectively. High yield in treatment T3 confirms the findings of Mahadeen (2014) that black plastic mulch was considered more appropriate for weed management resulting in maximum fruit yield and growth. In this experiment, plastic mulching favoured the plant growth and development in terms of larger size and weight of the fruit. The size of the fruit in treatment T3 was larger than that of T1 and T2 by 15-20 %. Larger size of fruit resulted significantly higher weight. The average weight of fruit under treatment T3 was 650 g as compared to 325 g and 369 g under treatments T1 and T2, respectively (Table 2). As compared to farmers practice (T1), the yield obtained under treatment T3 was 26.7 % higher, while it was 8.3 % higher in T2. Heavy weed infestation in non-mulched treatments (T1 and T2) led to reduced brinjal yields under these treatments, but the difference in yields obtained under these treatments was statistically non-significant. It is

worth mentioning that, non-mulched furrow irrigated raised bed system resulted in 31.2 % water saving with 8.3 % higher yield over control, implying that furrow irrigation for brinjal cultivation should be preferred over check-basin irrigation. The above findings are in agreement with the results of Singh *et al.* (2017) that mulching significantly increases the yield of brinjal up to 49.69 per cent.

Water Productivity (WP)

The average water productivity recorded in treatments T1, T2, and T3 was 31.34, 49.32 and 88.49 kg.ha⁻¹.mm⁻¹, respectively (Table 3). Water productivity in treatment T3 was significantly higher than that observed under treatments T1 and T2. Less water requirement and high yield in T3 resulted in 182.4 % more water productivity in comparison of control (T1); while it was 57.4 % more than in treatment T2 (Table 3). Ma *et al.* (2018) also reported that the plastic mulching significantly increases crop water productivity by 76 % and 40.2 % in spring maize and potato, respectively, in arid conditions.

Benefit-Cost-Ratio (BCR)

Category-wise break-up of the cost of brinjal cultivation per hectare and average BCR value is presented in Table 4. The cost of tillage operations remained the same in all treatments. Broadcasting of manure and fertilizer increased input cost in treatment T1 by 34.9 % than T3 as it was applied on the check basin. Due to higher number of irrigations under non-mulched treatment (T1), the cost of irrigation was also higher for treatment T1 as compared to T2 and T3. Application of plastic mulch led to reduced weed infestation and the labour cost on weeding was lower in treatment T3 by ₹ 6000/-.

Lesser fertilizer and manure requirements in treatment T2 decreased the cost of cultivation by 6.5 % in comparison of treatment T1. Preparation of raised

Table 3. Crop yield, water use and water productivity of brinjal under different treatments

Sl.No.	Attribute/Treatment	T1	T2	T3	Critical difference (CD)	Per cent change over	
						T1	T2
1.	Irrigation depth, mm	537.5 ^c	369.8 ^b	300.5 ^a	2.16	(-)31.2 [†]	(-)44.1
2.	Yield, t.ha ⁻¹	16.81 ^b	18.21 ^b	21.29 ^a	1.75	8.3	26.7
3.	WP, kg.ha ⁻¹ .mm ⁻¹	31.34 ^c	49.32 ^b	88.49 ^a	8.51	57.4	182.4

*Means with different superscripts in a row are significantly different at $p < 0.05$, T2/1: Percent change in parameters of T2 over T1, T3/1: Percent change in parameters of T3 over T1, Negative sign indicates percent savings in irrigation depth

Table 4. Cost of cultivation and benefit-cost ratio of brinjal cultivation under different treatments

Sl. No.	Particular	Unit	T1			T2			T3		
			Quantity /Number	Rate, ₹	Amount, ₹	Quantity /Number	Rate, ₹	Amount, ₹	Quantity /Number	Rate, ₹	Amount, ₹
1.	Tillage										
A	Rotavator	h. ha ⁻¹	4	850	3400	4	850	3400	4	850	3400
B	Preparation of plot	Man-day.ha ⁻¹	20	150	3000	40	150	6000	50	150	7500
2.	Manures and fertilizer										
A	FYM	t.ha ⁻¹	1	8000	8000	0.75	8000	6000	0.75	8000	6000
B	Urea	kg.ha ⁻¹	100	5.36	536	75	5.36	402	40	5.36	214.4
C	DAP	kg.ha ⁻¹	130	22.5	2925	90	22.5	2025	55	22.5	1237.5
3.	Seed cost	₹ ha ⁻¹	1100	-	1100	-	-	1100	-	-	1100
4.	Plastic Mulching (1.2 m × 1000 m)	Roll.ha ⁻¹	-	-	-	-	-	-	4	3500	14000
5.	Nursery and transplanting cost										
A	Raising nursery	Man-day.ha ⁻¹	8	150	1200	8	150	1200	8	150	1200
B	Transplanting	Man-day.ha ⁻¹	40	150	6000	40	150	6000	40	150	6000
6.	Intercultural operations										
A	Weeding	Man-day.ha ⁻¹	50	150	7500	50	150	7500	10	150	1500
7.	Irrigation										
A	Labour	Man-day.ha ⁻¹	10	150	1500	10	150	1500	10	150	1500
B	Fuel	l	128	68	8704	75	68	5100	62	68	4216
8.	Plant protection (pesticide cost)	₹ ha ⁻¹	-	-	1000	-	-	900	-	-	700
9.	Harvesting	Man-day.ha ⁻¹	40	150	6000	40	150	6000	40	150	6000
10.	Miscellaneous charges (Transportation and handling cost after harvesting)	₹ ha ⁻¹	-	-	2250	-	-	2250	-	-	2250
Total cost ₹. ha ⁻¹					53115		49377		56818		
Yield, t.ha ⁻¹					16.81		18.21		21.29		
Selling Price, ₹. ha ⁻¹ @ ₹ 7000 per ton					117670		127470		149030		
Net Profit, ₹. ha ⁻¹					64555		78093		92212		
Benefit-Cost Ratio					2.21		2.58		2.62		

beds and application of plastic mulching increased the cost of cultivation of treatment T3 by 6.5 %, and 13.0 % over treatments T1 and T2, respectively. Bhardwaj (2013) also reported an increase of 7.5-15.7 % in the cost of cultivation by the use of mulch.

The resource conservation (irrigation, fertilizer and labour) under plastic mulching led to substantial increase (26.7 %) in gross income over the control treatment. Un-mulched furrow irrigation in T2 marginally increased the income by 8.3 % over farmers practice (T1). The Benefit-Cost ratio worked out was 2.21, 2.58 and 2.62, respectively for treatments T1, T2, and T3. The benefit cost analysis suggests that the furrow irrigated raised bed system with mulching is the most profitable options followed by furrow irrigated raised bed system without mulching for brinjal cultivation in Unnao district of Uttar Pradesh.

CONCLUSIONS

The present experiment was set up at farmer's field to test the efficacy of furrow irrigated raised bed (FIRB) with and without black plastic mulch over farmer's practice of check basin irrigation. The study clearly demonstrated that higher brinjal yield could be achieved by adopting furrow irrigated raised bed (FIRB) with plastic mulch, simultaneously conserving the resources like water, fertilizer and labour. Experiment revealed that FIRB with plastic mulching led to additional yield of 4.48 t.ha⁻¹ over farmers practice with respective increase of 26.7 % in net income. Plastic mulching under furrow irrigations saved 237 mm irrigation water (44.1 %), 20 % labour charge in weeding and 34.9 % FYM and fertilizer over farmers practice. Raised bed with plastic mulching will address problem of water scarcity in vegetable growing tracts of central Uttar Pradesh along with higher crop yields.

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