POLY MULCHING – A CASE STUDY TO INCREASE COTTON PRODUCTIVITY

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Introduction

Mulching is the process of covering the soil surface to make favorable conditions for plant growth, development and efficient crop production. Mulching has been practiced in India since long time using mainly the crop residues including straw, stalk, leaves etc., But of late plastic mulches have come into use due to its inherent advantage of efficient moisture conservation, weed suppression and maintenance of soil temperature for faster mineralization. The advantages of using plastic mulches for the production of high value vegetable crops have been recognized since 1950's in United States and European countries. Polyethylene mulching conserves moisture because water that evaporates from the soil under the plastic film condenses on the lower surface of the film and falls back to the soil as droplets. Thus, soil moisture is conserved and consumed by the crop. The opaque mulches do not allow the sunlight to pass through and hence weeds growth is completely arrested. Fortnum et., al.,2000 reported the beneficial effects of plastic mulch for enhanced water and fertilizer utilization and weed control . Elias and Goldhamer (1991) reported an enhanced seed cotton yield of 39 % due to poly mulching. Nalayini et.al. (2004) reported an yield enhancement of 2.34 fold in Cotton cv LRA 5166 under polyethylene mulching.

Advantages of poly mulching

1. Poly mulching prevents direct evaporation of moisture from the soil and thus limits water loss and conserve moisture.
2. The moisture that evaporates under poly mulching is condensed below the mulched layer and reused by the crop.
3. The suppression of evaporation also has a supplementary effect as it prevents the rise of water containing salt, which is important in place where salty water is mainly used for irrigation.
4. Since minimum quantity of water is needed for poly mulched crop, 40 - 50 % saving of irrigation water which also indirectly helps in Ec reduction.
5. The loss of nutrients through leaching is kept minimum.
6. Opaque mulches prevent weed growth and saves weeding cost.
7. The favourable microclimate under poly mulching encourages plant growth promoting rhizospheric microbes and aids in faster mineralization of nutrients.
8. The moisture is always maintained nearer to field capacity which helps in earthworm multiplication.
9. The soil under poly mulching is friable and well aerated which is ideal for plant growth.
10. The soil erosion is completely arrested under poly mulching.

11. During heavy down pour, the rain water could not stagnate under poly mulching.
12. Root pruning is eliminated completely under poly mulching.
13. The poly mulched plants are sturdy and the pest like stem weevil attacks could not break the cotton plants even though galls are found in the stem.
14. The cotton leaves are thicker under poly mulching and attracts lesser incidence of sucking pest.
15. Reflective mulches helps in reduction of virus diseases.
16. Higher CO_2 assimilation and increased crop production efficiency.
17. Cleaner produce and no soil is splashed to the produce during heavy down pour and or irrigation.

Methodology

Raised bed of 1.2 m width was formed with irrigation channels on all around the bed. Paired row technique of 90/60x 60 cm for variety and 120 /60x 60 cm for hybrid. was adopted. The basal fertilizers (25% N, 25% K and full P) was given as basal before spreading the poly film. The poly ethylene film (30 or 50 micron) roll was placed above the raised bed, the sowing lines were marked on the polyethylene sheets using a sowing rope with markings at required spacing (45 /60 cm plant to plant). The sowing holes were made at required spacing using a 2 inch GI pipe and the sowing of cotton was done carefully in the sowing holes. After the sowing, irrigation was given immediately. The remaining dose of fertilizers was given as three equal splits at 45, 90 and 120 DAS. In the irrigation channel, intercrop green gram was sown and harvested at 65-70 DAS. The polyethylene sheets were intact even after the cotton harvest (cotton stalks were cut close to ground level below the cotyledonary leaves and a novel approach of sowing succeeding crop of maize was attempted under zero tilled condition without disturbing the layout (The fresh punching were made 5 cm away from cotton holes with the plant to plan spacing of 20 cm. The Maize cultivar cv., CORHM 4 was sown and irrigation was given. The basal fertilizers for maize crop was skipped and the first top dressing was given as DAP and MOP (about1/4) on 20 DAS and the remaining dose in three equal splits at 20 DAS interval.

Table 1. Influence of poly ethylene mulch on rhizosphere and phyllosphere micro organisms

Microorganisms	**Poly mulch**	**Non-mulch**
A. Rhizosphere (cotton) /g dry soil		
1. Diazotrophs	164.2×10^4	63.7×10^4
2.FacultativeMethylotrophs	109.2×10^4	26.4×10^4
3.Azospirillum	19.2×10^4	0.67×10^4
4. Phosphorus solubilizing bacterias	90.57×10^3	42.9×10^3
B. Phyllosphere (in cotton) /g of fresh leaf		
Pink pigmented facultative methylotrophs	134.6×10^4	39.3×10^4
C. Root Bits (in rotation maize)		
Arbuscular mycorrhizae infection	90.0 %	73.3 %

Table 2. Soil Temperature, Available soil moisture, Water use efficiency and population of *Rotylenchus reniformis* due to poly ethylene mulching

Treatments	Soil temperature Across depth ^{o}C	Increase over control	ASM % and WR*	WUE (kg seed cotton /ha cm)	***R. reniformis*** Population **
Poly Mulched	28.95	1.45	23.2	38.39	23.84 (4.73)
Control	27.50	-	20.03	10.07	110.7 (10.53)
CD (p= 0.05)	**-**	**-**	**-**	**-**	**2.29**

Water requirement* for polyethylene mulch: 52.46 ha cm
Water requirement* for non mulch: 88.46 ha cm
**Figures in parenthesis are square root transformed values.

Table3..Root characters of cotton cv LRA 5166 on 90 DAS due to polyethylene mulching

Treatments	**Root length (cm)**	**Root wt (g)**	**Root vol (cc)**	**Secondary roots**	**Root CEC/ 100 g roots**	**Root CEC/ pl**
Poly Mulched	27.2	4.24	12.73	23.17	24.30	1.03
Control	21.3	1.49	5.30	13.50	15.9	0.24
CD (p= 0.05)	**4.87**	**0.61**	**4.69**	**8.39**	**1.92**	**0.13**

Table 4. Leaf characters, biomass accumulation and uptake of nutrients by cotton cv. LRA 5166 on 90 DAS due to polyethylene mulching

Treatments	**Leaf nos/pl**	**Leaf area/leaf ($cm^{2)}$**	**Leaf dry wt g/leaf**	**Plant ht (cm)**	**DMP (g/pl)**	**N uptake g/plant**	**P uptake g/plant**
Poly Mulched	64.1	88.2	0.73	87.0	72.03	1.92	0.225
Control	36.2	56.1	0.60	53.2	28.20	0.77	0.078
CD (p= 0.05)	16.01	22.49	0.11	14.04	14.67	0.65	0.12

Table 5.Yield attributes, Seed cotton Yield, seed index, lint index of cotton cv LRA 5166 and grain yield of rotation maize due to polyethylene mulching

Treatments	**Bolls/ pl**	**Boll wt g/boll**	**Sympodia / pl**	**Seed cotton yield kg/ha**	**Seed index**	**Lint index**	**Maize grain yield kg/ha**
Poly Mulched	25.65	4.00	18.1	2067	9.00	4.63	6565
Control	15.1	3.50	15.9	890.7	8.93	4.53	3779
CD (p= 0.05)	**4.89**	**0.40**	**1.82**	**284.4**	**NS**	**NS**	**811.7**

The poly mulched cotton recorded manifold enhancement in beneficial micro organisms due to higher soil temperature, higher moisture, enhanced availability of nutrients due to faster mineralization, higher root volume etc. The favourable growth environment under poly mulching enhanced the seed cotton yield by 2.4 fold and an additional maize grain yield of 2.8 t /ha.

Response of Bt and Non Bt cotton under poly mulching

Table 6. Yield attributes and seed cotton yield of Bt and Non Bt cotton as influenced by poly mulching

Treatments		Sympodia/ plant	Bolls/ plant	Boll Wt (g/boll)	Seed Cotton Yield (Kg/ha)
Genotypes **A. RCH 20 Bt**					
1. Silver Colour Polymulching		22.0	70.0	6.73	4445
2. Black Colour Polymulching		22.0	63.3	6.69	4012
3. Control		16.67	40.7	6.50	2509
Mean		**20.22**	**58.0**	**6.64**	**3655**
B. RCH 20 Non Bt					
1. Silver Colour Polymulching		21.0	48.3	7.0	3203
2. Black Colour Polymulching		18.67	45.3	6.93	2977
3. Control		14.00	29.3	6.72	2193
Mean		**17.89**	**41.0**	**6.88**	**2791**
G	**CD (P= 0.05)**	1.29	5.59	NS	552.1
M	**CD (P= 0.05)**	2.23	9.62	NS	676.1
G x M	**CD (p= 0.05)**	NS	NS	NS	NS

Irrespective of the genotypes, poly mulching improved the plant height, leaf numbers, leaf area and DMP and root CEC significantly than non-mulching. The dry matter partitioning was favourably and significantly altered due to poly mulching as evidenced from the highest (70) bolls/plant in Bt and 48.3 bolls/plant in Non Bt under silver poly mulching). The boll weight was enhanced numerically in silver colour followed by black colour than non-mulching but not to the level of significance. The yield enhancement due to poly mulching ranged from 1503 to 1936 kg/ha for Bt cotton and 1010 to 784 kg/ha for non Bt cotton. Among the treatments, Silver colour poly mulching recorded the highest seed cotton yield of 4445 kg/ha in Bt cotton and 3203 kg/ha in non Bt cotton as against 2509 and 2193 kg/ ha respectively under conventional method

Table7.Yield and Yield attributes as influenced by genotypes, poly mulching and methods of planting

Treatments	Bolls/plant	Bolls/m^2	Boll wt	Seed cotton yield (kg/ha)	Seed cotton equivalent Yield (kg/ha)*
G1 M1 T1	118.3	131.0	7.3	51.30	5739
G1 M1 T2	119.2	132.0	7.3	5197	6494
G1 M1 T3	88.4	196.4	7.3	6644	7253
Mean	**108.6**	**153**	**7.3**	**5657**	**6495**
G1 M2 T1	95.0	105	6.1	3516	4125
G1 M2 T2	104.8	116	5.5	3852	5149
G1 M2 T3	70.0	156	5.3	4463	5071
Mean	**89.9**	**126**	**5.6**	**3943**	**4782**
G2 M1 T1	99.2	110	6.6	3653	4261
G2 M1 T2	86.6	96.2	6.5	3189	4486
G2 M1 T3	68.4	152	6.5	4530	5139
Mean	**84.73**	**119.4**	**6.5**	**3791**	**4629**
G2 M2 T1	82.1	91.2	5.5	2666	3275
G2 M2 T2	84.9	94.3	5.5	2652	3949
G2 M2 T3	67.4	149.8	5.4	3694	4303
Mean	**78.1**	**111.8**	**5.6**	**3004**	**3842**
CD(p=0.05)					
For G	**4.3**	**5.11**	**0.19**	**291.2**	**140**
For M	**4.3**	**5.11**	**0.19**	**291.2**	**140**
For T	**5.27**	**6.26**	**NS**	**356.5**	**172**

G1 – RCH 20 Bt, G2- RCH 20 non Bt, M1- Poly mulching, M2 –non mulching, T1 – single row planting , T2- Triangular planting(In a double row, the opposite plant was planted to intercrop) , T3 - Double row planting

*Intercrop radish yielded 5.5 t/ha under triangular planting

*Intercrop green gram yielded 426 kg/ha

Yield attributes and yield in RCH 20 Bt as influenced by genotypes, mulching and planting techniques:

Bolls/Plant and Bolls/m^2 (harvestable bolls)

Bt Cotton recorded significantly more number of bolls/plant than non Bt cotton. Irrespective of the genotypes, poly mulching enhanced the harvestable bolls/plant significantly than non mulching. Among the planting techniques, single row planting recorded significantly more bolls/plant for Bt genotype and triangular planting recorded more bolls/plant for non Bt genotype. However on per unit area basis (bolls/m^2), double row planting recorded significantly higher number of bolls/plant. The enhanced boll load on per plant basis under single or triangular

methods of planting could not compensate the population loss as compared to double row planting.

Boll weight

Bt genotype produced significantly heavier bolls than non Bt. Poly mulching recorded significant enhancement in boll weight as evidenced from 7.3, 6.53 g /boll respectively for Bt and non Bt cotton under poly mulching as compared to 5.6 and 5.47 g under conventional method. The boll weight was not significantly altered due to planting techniques.

Seed cotton yield:

Bt cotton recorded significantly higher yield than non Bt cotton. The Bt cotton recorded 49 % higher yield than non Bt under poly mulching and 31 % higher yield under conventional method. Poly mulching enhanced the seed cotton for both Bt and non Bt but the response was more for Bt cotton under poly mulching than non Bt cotton. The Bt cotton yielded on an average 5657 kg/ha under poly mulching as against 3943 kg/ha under non mulching. The non Bt cotton recorded 3791 kg/ha under poly mulching as against 3004 kg/ha under conventional method. Among the planting techniques, double row planting recorded the highest seed cotton yield and was found significantly superior to triangular and single row method. The triangular planting was on par with single row planting for seed cotton yield with an additional benefit of 5.5 t/ha of radish yield. The green gram grown on all around the raised bed in the irrigation channel yielded 426 kg of dried grains/ha.

Seed Cotton equivalent yield

In terms of seed cotton equivalent yield, the triangular planting was on par with double row planting.

Performance of ELS Bt Cotton RCHB, 708 under drip, Drip + Poly mulch and conventional method.

Table. Yield Performance of RCHB 708 as influenced by water conservation techniques and fertilization practices

Fertilization Treatments	Yield attributes			Seed Cotton Yield (Kg/ha)
	Sympodia/pl	Bolls/pl	Boll wt. g/boll	
Drip	22.3	76.3	5.35	5246
Drip + Poly Mulch	24..3	96.7	5.28	6423
Control	21.6	55.6	5.08	4272
CD (P=0.05) for W	0.96	4.51	0.15	334.9

ELS Bt cotton RCHB 708 responded favourably and significantly to Poly mulch + Drip and Drip system. The enhancement in seed cotton yield was 22.8 % due to drip and 50.4 %due to Drip + poly mulching. The poly mulch + Drip system recorded significantly higher seed cotton yield average of 6423 kg/ha followed by drip system without poly mulch with an average seed cotton yield of 5246 kg/ha as against the lowest seed cotton yield of 4272 kg/ha under conventional method

Water Saving, Growth, Yield and Quality of ELS Cotton under Poly mulching, Drip and Drip + Poly mulching

Treatments	Bolls/plant	SCY(kg/ha)	WR(ha cm)	WUE
Control	42.58	3450	95.8	36.0
Poly mulch	77.4	4982	55.8	89.0
Drip 0.4 Etc	67.4	4009	44.5	90.08
Poly mulch + Drip 0.4 Etc	82.5	5494	44.5	123.5
Drip 0.8 Etc	73.4	4551	53.3	85.4
Poly mulch + Drip 0.8 Etc	82.5	5486	53.3	102.9
CD (p=0.05)	**5.48**	**497**		

In another experiment to standardize the water requirement for ELS Bt cotton RCHB 708 under drip, poly mulching and Drip + poly mulching as compared to conventional Irrigation. The growth of cotton cv. RCHB 708 was influenced favourably due to poly mulching and drip + poly mulching and found better than drip irrigated cotton. The growth attributes like number of leaves/plant, leaf area, node and dry matter accumulation were higher under poly mulch + Drip at 0.4 Etc than Drip at 0.8 Etc. The poly mulch + Drip at 0.4 Etc recorded the highest number of harvestable bolls/plant with the highest seed cotton yield of 5494 kg/ha and this treatment combination recorded the lesser water requirement of 44.5 ha cm and the highest water use efficiency of 123.5 kg/ha cm. Poly mulching alone without drip is found significantly superior to drip alone either at 0.4 or at 0.8 Etc in terms of yield attributes and seed cotton yield. The conventionally irrigated cotton recorded the highest water requirement of 95.8 ha cm with the lowest water use efficiency of 36.0kg/ha cm.

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