Tropical Agricultural Research Vol. 5 1993

Influence of Poly-Ethylene Film Mulch on the Yield of Irrigated Chilli in the Dry Zone of Sri Lanka

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ABSTRACT. *A field experiment was conducted to evaluate the influence of Black Polyethylene Film Mulch on the dry pod yield of Chilli (Var. MI-2) during the dry Yala season of 1990, at the Regional Agricultural Research Centre, Maha Illuppallama.*

Black Polyethylene Film (PEF) mulch increased the yield of chilli significantly over the no mulch treatment. Under the influence of PEF mulch, an irrigation interval of once in 20 days resulted in higher yields than mulched treatment with 14 days irrigation interval and equivalent irrigation intervals without mulch.

Under the experimental conditions, reducing the fertilizer application to 50 percent of the recommended dosage has not indicated any significant yield reduction, irrespective of the mulching and irrigation intervals used.

Assessment of costs and benefits and efficiencies indicated that using the black PEF mulch has given a cost:benefit ratio of 1:3.7, an almost two fold yield increase, and an almost two fold increase in water use efficiency.

INTRODUCTION

Annually chilli is grown to around 15000 ha under irrigated conditions and a similar extent under rainfed conditions in the dry zone of Sri Lanka (Department of Agriculture, 1991). Most of the rainfed chilli is grown during the wet *Maha* season, whereas the irrigated chilli is grown mostly during dry *Yala* season.

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A major portion of chilli cultivation is estimated to be under new improved varieties namely. MI-1 and MI-2. The latter is specifically grown under irrigated conditions, due to its high yielding ability (yield potential of 2.0 Mt/ha under farm conditions) within a short period of 4-4 1/2 months. However, field observations indicate that these varieties do not produce up to the expected potential yields at farmers' fields. A wide variation in the average yield under farm conditions may mislead estimated national production figures which is reflected in many official documents repeatedly (Department of Agriculture, 1983-1991). The chief causes for low productivity in chilli are suspected to be insufficient water availability with respect to time and quantity, insufficient nutrient availability, weed competition for nutrients and moisture, and, damages due to pests and diseases. These have been identified by very early agricultural researchers without any specific mention of a crop (Abeyaratne, 1956 and Panabokke, 1959).

Chilli is grown in irrigation projects mostly during dry *Yala* season to obtain higher profitability from land and water resources through crop diversification when water stored in the reservoir is insufficient to grow rice. The diversified crops also are often subjected to temporary water scarcities though they are supplied with intermittent irrigation of a fixed rotation. Irrigation rotation adopted in common, varies between once in 7-10 days according to the availability of water but it is not adjusted according to the more scientific approach of considering the stage of the crop and environmental requirements. As a result, the crop may experience over or under irrigation.

The evapotranspirative requirement increases rapidly as the season progresses. The total modal *Yala* rainfall is barely sufficient to meet the average evapotranspirative requirements for the season. Consequently, a very high unreliability of moisture availability is experienced at the vicinity of root system and in general in the total soil profile. The problem is not fully resolved yet due to operational obstacles although it has been well addressed in the development of irrigation technology. The effectiveness of other approaches such as mulching therefore, have to be investigated with respect to resolving this problem.

Use of different kinds of mulches had been a practice adopted from ancient times to conserve soil and moisture. Straw and stubble mulches are the most commonly used types. Comparatively recent introduction as a mulch material is Polyethylene Film Mulch (PEFM) of which the advantages has been known as early as 1950's (Spice, 1959).

PEFM acts as a total barrier for moisture gradient developed between soil and air, reducing the free flow of moisture through evaporation. Permeability of polyethylene (PE) to water vapour is negligible compared with those to most inorganic and organic gases (Henderson, 1960). These characteristics are supposed to be helpful in delaying the need of irrigation and extending the availability of moisture to the crop for a longer duration.

The PEFM reduces the entry of rain or irrigation water into the soil (Spice, 1959 and Henderson, 1960) and reduces the direct impact of rain drop on soil, thus preventing the soil erosion and consequent nutrient loss. In addition, this character will reduce the percolation process, resulting in reduced leaching of nutrients out of root zone.

Moore (1989) has reported that the Carbon Dioxide accumulated under the PE film mulch has led to the decrease in soil pH value, resulting in higher uptake of Zinc and consequent higher yields in tomato. Using black PEFM has an added advantage of reducing the visible range of solar flux received on the soil surface, thereby, reducing the germination and growth of weeds. (Spice, 1959 and Henderson, 1960). As a result, it will reduce the competition by weeds with crop for water and nutrients.

The objective of this study was to evaluate the influence of Black PEFM on the yield of irrigated chilli, and its economic feasibility as a lay-flat soil mulch.

MATERIALS AND METHODS

The experiment was conducted in Catchment C of Regional Agriculture Research Centre, Maha Illuppallama, on the upper aspects of well drained slopes, in the catena. Soil belongs to Rhodustalf (Reddish Brown Earth). The study was conducted from first week of May to last week of September, 1990, in a Split-Split-Plot design with five replications.

Experiment consisted of three treatment factors, *viz.* irrigation interval, mulch, and fertilizer level, each with two levels (Table 1), so that there were eight treatment combinations of irrigation interval x mulch x fertilizer level in the experiment.

Table 1. Different levels of treatment factors used in the study.

Irrigation Interval	Mulch levels	Fertilizer levels
14 days (I1)	M1-black PEFM	F1-50% of recommen.
20 days (I2)	M1-black PEFM	F2-100% of recommen.
7 days (I1)	M0-no mulch	F1-50% of recommen.
10 days(I2)	M0-no mulch	F2-100% of recommen.

Land was prepared for a furrowed basin irrigation system and all other subsequent agronomic practices were adopted as recommended. (Crop Recommendation Technoguide, Department of Agriculture, 1992). Basal dressing was incorporated into the soil and then the black PEFM of 0.005 cm thickness, was laid on top of the beds, covering the side slopes. Slots (15 cm x 15 cm) had been cut on the PEFM before laying, to facilitate for planting and other subsequent operations, at the pre-determined spacing as recommended for chilli. Three weeks old chilli seedlings of variety, MI-2, were planted in the spaces provided in the slots. Top dressings were also applied into the slots.

For no mulch treatment, an irrigation interval of 7 days was selected based on the normal practice of irrigation rotation in the field. It was extended by another 3 days (10 days interval) to provide a different depletion level. A practical method of determining the corresponding irrigation intervals for the mulched treatments was required to overcome constraints[2] experienced during the study period. Therefore, the water requirements of 7 and 10 days rotation were first computed. Quantity of water to be applied was estimated according to the basin size and the criteria adopted in evaluating the irrigation requirement, to be approximately 270 litres and 400 litres for I1 and I2 respectively. These quantities of water were applied for mulched treatments to select the corresponding irrigation intervals, by the feel method (Israelson and Hansen, 1962). The required intervals were found to be approximately 14 and 20 days respectively. Measured quantities

[2] The major constraint during the study period was the civil unrest that prevailed in the country. Because of the disruption to electricity supply and labour problems, accepted standard technique such as gravimetric sampling could not be practiced to determine correct depletion levels.

of water were applied into the basins constructed around the bed, using graduated plastic containers.

Statistical analysis of yield data was based on an analysis of variance. Water Use Efficiency was calculated by taking into account of the rainfall and irrigation water applied at each irrigation and the mulch interaction during the study period assuming the other hydrological components to be equal in all treatments. Economic feasibility was calculated by comparing the costs of PEFM application plus savings on other operations due to its application, with the cost of production of a normal chilli cultivation under irrigation during dry *Yala* season. Cost for water was calculated as for fuel pump-irrigated chilli cultivation.

RESULTS AND DISCUSSION

Two irrigation intervals could be maintained during the months of June and July, due to absence of rain. During the months of August and September, a total rainfall of 198mm was received out of which 153mm (77%) has occurred within four days at different periods.

The total chilli yields obtained for the different treatment combinations are presented in Table 2.

Effect on yield

Three-way interaction effect of between irrigation, mulch and fertilizer (IxMxF) was found to be not significant. The only two-way interaction effect found to be significant was I x M. Thus, I x M interaction was studied (Table 2), using the yield response (Figure 1).

There was no significant yield difference between irrigation intervals under no-mulch treatment, while a significant yield increase was observed at 20 day interval (I2), over the 14 day interval (I1), when the plastic mulch was used.

Irrespective of the nature of the interaction between irrigation interval and mulch, mulching has always shown to be beneficial in terms of chilli pod yield, over no mulch, under the experimental conditions. The once in 20 days irrigation and mulched treatment has given a relative yield increase of 178% whereas the once in 14 days irrigation with mulch has increased the yield only up to 136%, when both were compared with the treatment of once in seven days irrigation and no-mulch.

Table 2. Chilli dry pod yield (kg/ha) at different irrigation intervals, plastic mulch and no mulch, and at different fertilizer levels in 1990 *Yala* season at Catchment C, RARC, Maha Illuppallama.

	Irrigation Interval			
Fertilizer	I1 Unmulched (MO)	I1 Mulched (MI)	I2 Unmulched (MO)	I2 Mulched (MI)
Half recommended dosage	803a	1148b	879a	1418ab
Full recommended dosage	883a	1159b	884a	1585ab
Average	843	1153	881	1501

Figures followed by the same letters within a row are not statistically significant.
Yield under two fertilizer levels are not significant under any irrigation or mulch treatments.

CV for main plot (depletion levels) = 28.9
CV for subplot (mulching treatments) = 18.7
CV for sub sub plot (fertilizer levels) = 12.1
* LSD'(0.05) to compare I x M treatment combination (kg/ha)= 211

When the influence of fertilizer on the chilli pod yield was considered, no significant difference was found between the recommended fertilizer level and half the dosage. Thus, it appears that it is possible to reduce the recommended level of fertilizer under the adopted irrigation intervals irrespective of mulching. However, this aspect should be further investigated.

The beneficial effects of plastic mulching may be due to the absence of weed growth, and better moisture availability for a longer duration. Evaporated soil moisture is entrapped beneath the plastic mulch, condenses underside and fall back to the soil. Thus, reduced soil moisture losses and enhanced circulation of it under the plastic mulch, may have increased the availability of nutrients present in the soil at the vicinity of roots. In addition, plastic mulch may have helped in the reduction in loss of nutrients due to volatilization, which were applied as fertilizer. The complete absence of weeds would also have eleminated the weed competition for nutrients and moisture.

Water use efficiency

Water Use Efficiency (WUE) is the amount of yield obtained per unit of water used.

Field WUE (kg/mm. water) = Yield (kg)/Water used (mm. of water).

Total water used was calculated by adding the total rainfall to total irrigation applications for each combination of irrigation and mulch treatment during the experimental period. Deep percolation from irrigation was considered to be negligible since water requirement was estimated to match with the root depth. Deep percolation from rainfall was considered to be equal over all the treatment plots. Average dry pod yields over treatment combinations were considered (Table 3).

Table 3. Total rainfall, irrigation amd water use and the average pod yield for each combination of irrigation and mulch treatment considered for calculating the WUE.

	I1 Unmulched	I1 Mulched	I2 Unmulched	I2 Mulched
Total rainfall (mm)	355.8	355.8	355.8	355.8
Total irrigation (mm)	452.6	269.6	441.2	229.2
Total water used (mm)	808.4	625.4	797.0	585.0
Average yield (kg)	843.0	1153.0	881.0	1501.0
Field WUE (kg/mm water)	**1.043**	**1.844**	**1.105**	**2.566**

PEF mulch with a 20 day irrigation interval has resulted in the highest Field Water Use Efficiency (FWUE). This increase in WUE was more than 200%, over WUE of unmulched treatments with seven and ten day irrigation intervals.

WUE is increased by reducing the main components of water loss from a crop, *viz.* soil evaporation, crop evapotranspiration, and deep percolation. Soil evaporation is the only component that can be controlled by the PEF mulch. Results indicate that PEF mulch has effectively reduced the soil evaporation thereby increasing the WUE.

Economic feasibility

Expenditure on PE film and laying per ha.	= Rs. 32434.00
Saving on weed control and water application per ha.	= Rs. 30080.00
Indicative yield increase of 75% over 1500 kgs/ha rate	= kgs 1125
Value of increased yield due to PE mulch (Rs.80/kg)	= Rs. 90000.00
Value of benefit from PE mulch (90000+30080)	= Rs. 120080.00
Cost : benefit ratio of PE film (32434:120080)	= 1:3.70

The results indicated that the cost benefit ratio of application of PE film mulch was 1:3.70. However, further studies are required in this respect to identify the suitable thickness of the film, ideal level of black pigmenting, and ultra violet stabilization. These factors will affect the yield as well as the reusability of the PE film.

CONCLUSIONS

The use of polyethylene film as a mulch for chilli appears to be economical in terms of expenditure on a number of cultivation practices, cash inflow, and net income. Plastic mulching appears to be an effective method of moisture conservation in the dry zone of Sri Lanka, since it can increase the yield of chilli while reducing the irrigation requirement. Further, it was observed that the plastic mulch can control weeds completely. However, it is recommended to conduct further studies to determine the suitable moisture depletion level and fertilizer combinations which produces the optimum yields.

REFERENCES

Abeyaratne, E. (1956). Dry Land Farming in Ceylon. Tropical Agriculturist. Vol XII: pp. 191-229.

Department of Agriculture (1990). Crop Recommendation for adoption in grama niladari divisions of Sri Lanka. Agrotechnical information.

Division of Agricultural Economics and Planning (1983-1991). Cost of cultivation of agricultural crops. Department of Agriculture.

Division of Technology Transfer (1991). Compendium of Cultivation data (unpublished). Department of Agriculture.

Israelson, O.W. and Hansen, V.E. (1962). Irrigation Principles and Practices. John Wiley and Sons.

Moore, F. (1989). Black Poly, CO2 - 9% Yield boost. Ag. Consultant. pp. 16.

Panabokke, C.R. (1959). Water consumption pattern of crops in the dry zone environment. Tropical Agriculturist. Vol. CXV: pp 187-194.

Spice, H.R. (1959). Polythene film in horticulture. Chapt. 10. Faber and Faber, London. pp 131-138.