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Analytical Study of Plastic Mulching in Tuberose and Melons in Dharmapuri District of Tamilnadu

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Authors' contributions

This work was carried out in collaboration among all authors. Author KI designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author PSS managed the analyses of the study. Author MS managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Dharmapuri is a versatile district with a wide variety of crop diversity from millets to vegetables under protected cultivation. Tuberose and melons are livelihood crops for small and marginal farmers with limited irrigation water source. About 80% of the cost of cultivation is spent on weed management in tuberose. Productivity in melons is affected due to soil-borne diseases and fruit flies. Front line demonstrations for the use of plastic mulching was conducted to address the issues. The demonstrations were conducted in farmers' fields and each farmer field is considered as one location. Results of the demonstrations were analysed in various perspectives including economic benefits so as to showcase the positive outcome of the plastic mulching technology. There was about 15 – 20% increase in the melons and 18 - 22% in the case of the tuberose. Though the increase in productivity cannot be correlated only to plastic mulching, the improvement in the fruit quality (95% of first grade fruits) attributed by plastic mulching especially in melons. Weed management cost was reduced in tuberose by 80%. In melons the reduced crop duration by 6 – 8 days indirectly reduced the cost of cultivation and added to the net returns of the crop. The economic benefit of the technology were realised by farmers.

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1. INTRODUCTION

A wide variety of crops are cultivated in Dharmapuri district *viz.* millets, groundnut, sugarcane, vegetables, flowers and also crops under protected cultivation. Tuberose is an important flower crop of Dharmapuri district grown in an area of about 1400 hectares. It is a livelihood crops for small and marginal farmers. It gives a regular weekly income to the farmers and is also a profitable crop. About 80% of the cost of cultivation is spent on weed management in tuberose [1]. Hand weeding is done once in 20 – 25 days. Hence the net profit of the farmers is lesser though the productivity and gross returns are not meagre.

In the case of melons, watermelon and muskmelon are grown in an area of about 590 hectares. The cultivation of melons in Dharmapuri district is concentrated in Morappur and Pappireddipatti blocks of Dharmapuri districts. These blocks are under severe irrigation water scarcity especially during Rabi season. So, the farmers using the drip system prefer a short duration and remunerative crop. Melons are the first a choice of farmers as more profit can be obtained in 65 – 70 days. Sometimes the irrigation water scarcity is so that even the short duration melons get insufficient water. Also the productivity was affected due to soil-borne diseases, fruit flies and pumpkin beetles. *Fusarium* wilt can affect the melons right from the seedling stage. The percentage of damage ranges from 30 – 80% based on the climatic conditions [2]. The field uncared for the fruit fly damage may suffer a yield loss between 20 – 40%. The fruits attacked in early stages fail to develop properly and drop or rot on the plant [3].

2. METHODOLOGY

Based on the above background, Krishi Vigyan Kendra demonstrated the use of plastic mulching for tuberose and watermelon in Pennagaram and Morappur blocks respectively during the year 2013-14.

Low-density polythene (LDPE) of a thickness of sheet should be more than 40 micron and colour of the mulch – Top silver and bottom black was used. The field was ploughed to fine tilth, raised bed formed, removal of pebbles stones and clods on the surface ensured. Otherwise it may damage the mulching sheet, the drippers should be checked for proper discharge of water. The drip laterals perfectly placed on the center of the raised bed, ensuring that plastic mulch spread evenly without an wrinkles. Spreading the sheet during sunny hours should be avoided. It may elongate the sheet and when the temperature gets down it shrinks and may lead to the damage of the sheet. Organic manure, biocontrol agents and basal dose of fertilizers has to applied before mulching. Plastic mulch sheet was spread along the raised bed and soil earthed up in the furrows perfectly to fit the mulch sheet in position. Holes at recommended spacing were made with heated GI pipes of 2 inches and planting.

Front line demonstrations on plastic mulching in Tuberose and Watermelon were conducted in five farmers' field in Pennagaram block and Morappur blocks respectively. Pennagaram and Morappur blocks are drought prone blocks of Dharmapuri district. Tuberose is a major crop in Pennagaram (Sompatti cluster) and melons during Rabi in Morappur block (Annamalaipatti cluster). The farmers were selected based some criteria *viz.* interested farmers ready to adapt the mulching technology in contact with KVK in that particular cluster, farmers those who have already installed drip system, and are cultivating these crops in for past three or four years. Those farmers who are already growing tuberose and melons are alone selected because they can only clearly distinguish the differences in adapting the critical technology *i.e.* plastic mulching. The selected farmers are explained about the technology and the technologies to be followed in a group discussion. Then demonstration of the spreading of plastic mulch, making holes and planting are demonstrated. Tuberose and melons with and without mulch was compared. The crop without mulching is the check to compare the performance of the mulched field. The plastic mulching sheet was the only critical input given to the farmers. The adaption of other ICM technologies to be adapted is ensured by frequent visits by the KVK scientists.

3. RESULTS AND DISCUSSION

The farmers involved in demonstration maintained a record of all the activities taken up in the demo plots and the expenses towards crop production. The yield and income also recorded. The record helped them to realize the difference before and after adaption of the technology.

3.1 Improvement in Yield and Quality

Improvement in productivity by use of plastic mulching was presented in Figs. 1 - 3. Yield increase was recorded as 15 – 20% in melons and 18 - 22% in case of tuberose than the check. Similar increase in yield due to plastic mulching were reported in Tomato, Chillies and many vegetables [4,5,6]. The increase in productivity cannot be correlated only to plastic mulching. But the improvement in quality of the produce is attributed by plastic mulching especially in melons. There will cause discolouration in the melons in the portion which was in contact with the soil without plastic mulching. The fruits from the demo plots with plastic mulching showed no discolouration and the fruits were of uniform colour. The improvement in fruit quality increased the market price of fruits per kilogram. Also the earliness in the days to harvest is the significant advantage in cultivation of melons under plastic mulching. The crop is ready for harvest 6 – 8 days than the crop without plastic mulching. In tuberose the flower buds were bolder than the flowers from unmulched field. The current study recorded that the flowers from the plastic mulched field weigh more than the flowers cultivated conventionally.

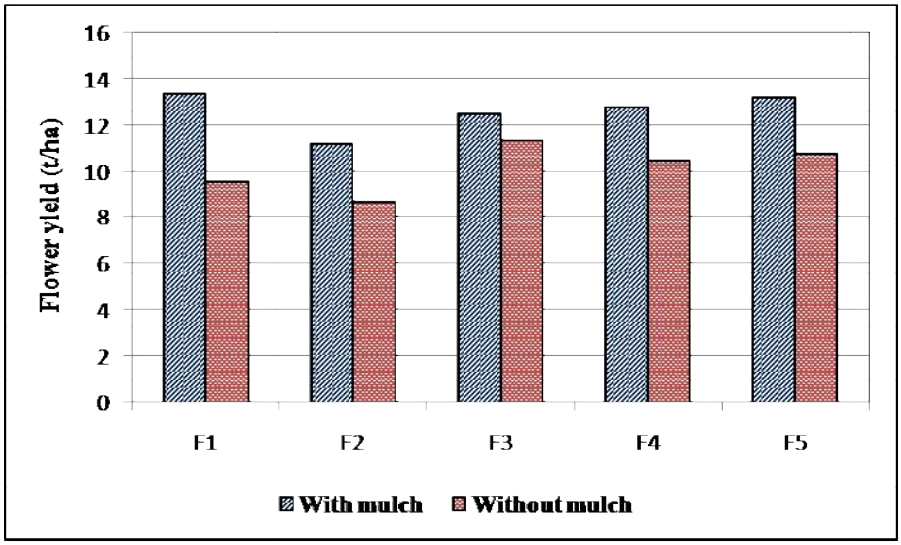

Fig. 1. Comparison of flower yield in plastic mulched and unmulched field in tuberose

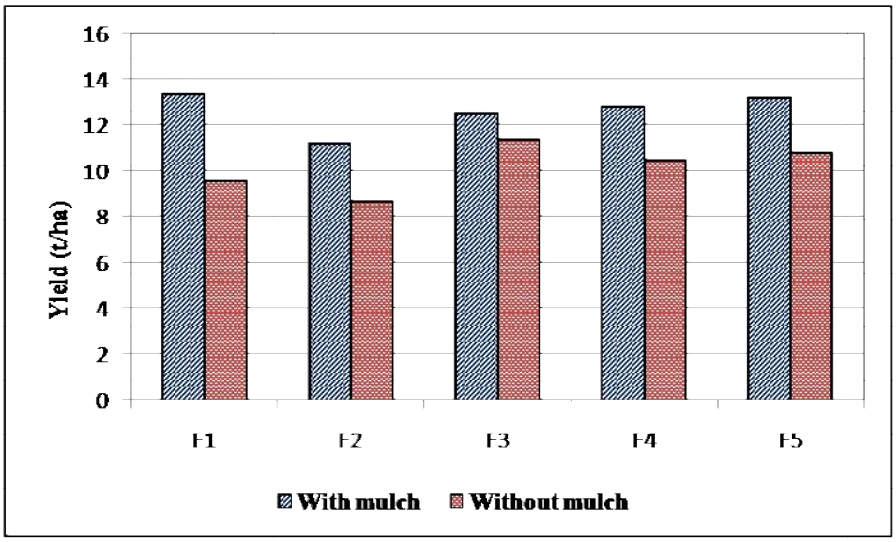

Fig. 2. Comparison of yield in plastic mulched and unmulched field in watermelon

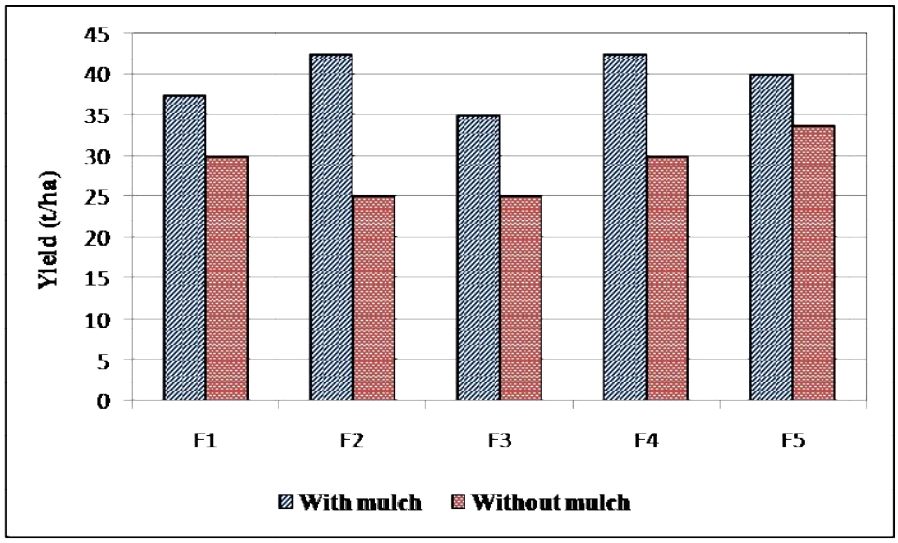

Fig. 3. Comparison of yield in plastic mulched and unmulched field in muskmelon

3.2 Pest and Disease Incidence

In melons the incidence of *Fusarium* wilt is the major problem as described in the problem statement. In the fields under plastic mulching the incidence of thrips reduced to a tune of 80%. The percent disease incidence (PDI) in the mulched field is only about 5 – 8% as against 30 – 75% in the fields without plastic mulch. The demo plots evidently recorded reduction in viral disease incidence. The reduction in incidence of viral diseases may attributed to both the improvement in the crop health and also the reduced vector population which may be due to the glittering effect of the top silver colour of the mulching sheet.

The fruit flies and pumpkin beetles are the yield limiting factors in melon cultivation. The incidence of fruit flies and pumpkin beetles were less in the mulching fields than the other control fields. The pupation sites for these pests are soil. As the mulching effectively reduces the chance of pupation of these pests the damage due to this pest is less compare to unmulched fields. A similar report in the management of fruit flies with mulching is reported by [7].

In tuberose mealybug, wilt and nematode are the primary concern for the growers. Even though the mulching technology directly not impeded the incidence of pest and diseases in tuberose it the ICM practices adopted along with the mulching technology reduced the incidence. The mealybugs hide in the cracks and crevices in the fields. Mulching reduces the chance of hiding in these places thus increasing the efficiency of management measures. In the same way reduced wilt diseases incidence was noticed in the mulched fields.

3.3 Economic Benefits

In the case of the tuberose the reduction in cost towards weed management is the significant difference inferred by the farmers. The results in terms of economics are given in Table 1. In the case of tuberose weed management holds about 80% of the cultivation cost. The weed management was reduced to a tune of 10 – 15% of the cultivation cost by using plastic mulch. Only the furrows need to be weeded. Also the weed population is comparatively minimum as they are daily walking in the furrow space for the harvesting of flowers. As tuberose is a two to three years crop, the performance of crop is excellent even in the summer months in the plastic mulched field where as the nearby fields suffered due to irrigation water scarcity. The microclimate in the rhizosphere is conducive for crop growth which helps in good crop growth and yield [8]. Increase in yield in tuberose was recorded in many research reports [9,10,11].

In melons the reduced crop duration by 6 – 8 days indirectly reduced the cost of cultivation and added to the net returns of the crop. Also the improvement in the quality of fruits fetched an additional price of Rs. 1 -1.50 per kilogram. Also the farmers used to take three crops Watermelon – Muskmelon – Watermelon in the same plastic mulched field. Repeated cultivation under same

mulch reduced the field preparation cost and efficient use of the plastic mulch. If at all plastic mulch is not used, they cannot think of the same melon group continuously as it will increase the incidence of soil-borne problems. But the plastic mulch helped for the continuous cultivation of the melons thrice in the same field. Increase and yield and economic returns in watermelons were reported by [12].

There is a significant reduction in irrigation water usage in the demonstration plots with plastic mulching than the plots without plastic mulching. The frequency and time of irrigation was reduced in both melons and Tuberose (Tables 3 & 4). The reduced incidence of pest and diseases in the mulching fields decreases the cost spent towards the plant protection.

3.4 Gain in Knowledge and Skills in Plastic Mulching

The farmers involved in the demonstrations gained the knowledge and skill on use of plastic mulching as listed in Table 5. As a part of up scaling the technology of plastic mulching, a Farmers' school was conducted in association with ATMA on 'ICM in watermelon under plastic

Table 1. Cost of cultivation and returns for plastic mulched and unmulched fields in tuberose

Details	Cost of cultivation / ha (in Rs)	
	With mulch	Without mulch
Rhizome	22500	22500
Land Preparation	5000	5000
Mulch sheet & spreading	37500	-
Planting	3000	2000
Irrigation	2500	5000
Weed management	5000	50000
Fertilizer	18750	18750
Plant Protection	2500	2500
Harvest	15000	15000
Total	116250	123750
Yield (tonnes)	12.60	10.20
Returns		
Cost per kg	40	40
Gross returns	504000	408000
Net returns	192190	128750
BCR	4.3	3.2

Table 2. Cost of cultivation and returns for plastic mulched and unmulched fields in watermelon

Details	Cost of cultivation / ha (in Rs)	
	With mulch	Without mulch
Seed	17500	17500
Land Preparation	5000	5000
Mulch sheet & spreading	12500	-
Sowing	2500	1250
Irrigation	2500	5000
Fertilizer	13750	11250
Weed management	750	6250
Plant Protection	5000	10000
Harvest	3000	3000
Total	60000	61750
Yield (tonnes)	48.5	39.0
Returns		
Cost per kg	8	7.50
Gross returns	388000	285000
Net returns	302250	223250
BCR	6.4	4.6

mulching' in the Pappireddipatti block. A participant of the farm school was educated on the mode of making holes with GI pipes. He modified the hole maker and his innovation was recognised in the Indian Horticultural Congress 2014.

3.5 Methods Adopted for Horizontal Spread of the Technology

a. The frontline demonstration was conducted.
b. Popularised through training programmes
c. Farm school was conducted in association with State Department of Agriculture in Karimangalam and Pappireddipatti blocks
d. Through Irrigated Agriculture Modernisation and Water-bodies Restoration and Management (IAMWARM) scheme this technology was demonstrated to 200 farmers in the Morappur, Karimangalam, Nallampalli and Palacode blocks in the Kambainallur sub-basin area.
e. Through Mission for Integrated Development of Horticulture mulching technology has been demonstrated in all blocks of Dharmapuri district. The area of adaption was more in Morappur, Harur and Pappireddipatti blocks (Fig. 4 and Table 6).

Table 3. Advantages of plastic mulching over unmulched field in tuberose

S. no	Parameter	With mulch	Without mulch
1.	Weed density (No./m^2)	12.0	60.0
2.	Cost towards mulching	32500	-
3.	Cost towards weed management	5000	50000
4.	Reduction in cost towards weed management	90.0	-
5.	Frequency of irrigation (Interval in days)	6	2

Table 4. Advantages of plastic mulching over unmulched field in watermelon

S. no	Parameter	With mulch	Without mulch
1.	Weed density (No./m^2)	7.0	38.0
2.	Cost towards mulching (shared for three crops)	12500	-
3.	Cost for weed management	750	6250
4.	Reduction in cost towards weed management	88.0	-
5.	Frequency of irrigation (Interval in days)	3	Daily
6.	Marketable quality of fruits (Percentage of first-grade fruits)*	97.3	85.9
7.	Wilt incidence (PDI)	5- 8	30 - 75
8.	Incidence of pumpkin beetle (%)	8.0	20.0

**First-grade fruits – Without cracks, blemishes and without distortion*

Table 5. Gain in knowledge and skills in plastic mulching

S. no.	Knowledge / Skill on	Before demonstration	After demonstration
1.	Is aware of the importance of the use of plastic mulching	No	Yes
2.	Is aware of the specifications of the plastic mulch sheet to be used	No	Yes
3.	Is aware of the operations to be completed before spreading mulching sheet *viz.* basal dose of applications, fine tilth, checking drip laterals *etc*.	No	Yes
4.	Can do the mulch sheet spreading efficiently	No	Yes
5.	Is aware of techniques involved in making holes in the mulching sheet	No	Yes
6.	Know-how on the disposal of the mulching sheet and the possibilities of recycling	No	Yes
7.	Is aware of the *Don*'ts in adapting mulching such as the use of LDPE less than 30 microns.	No	Yes

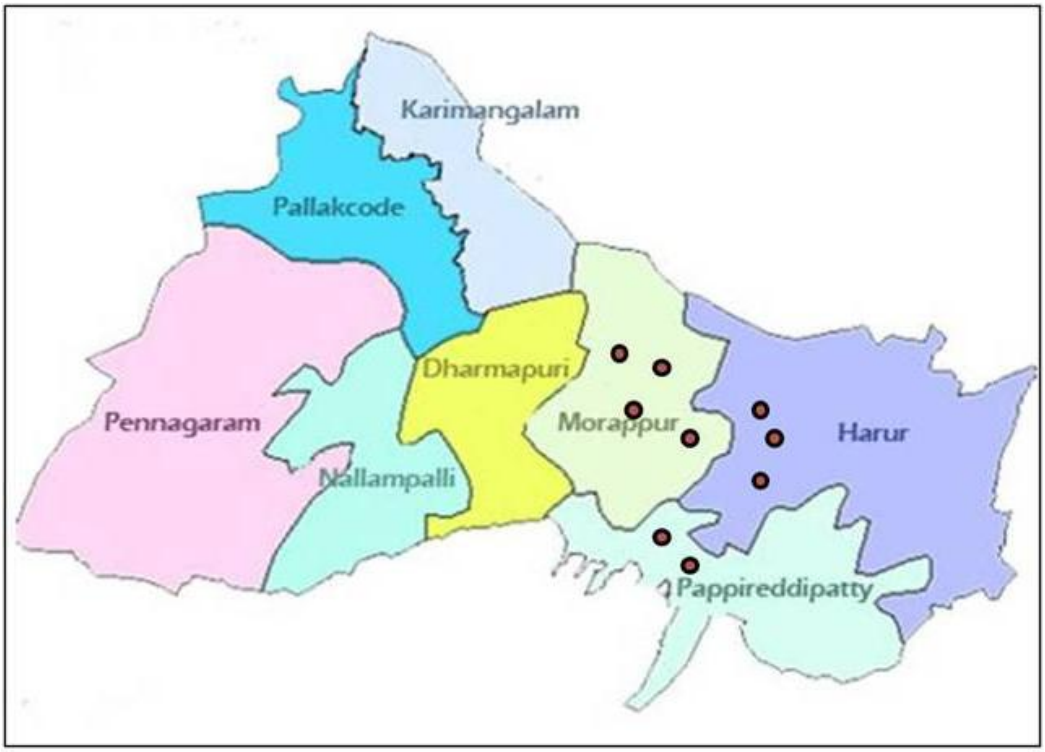

Fig. 4. Areas in three blocks of Dharmapuri district where adoption of mulching is concentrated

Table 6. The area under plastic mulching in various blocks of Dharmapuri district

S. no.	Block	Crops	Area (ha)
1.	Dharmapuri	Tuberose	75
2.	Nallampalli	Tuberose, Brinjal	50
3.	Pappireddipatti	Melons	125
4.	Morappur	Melons	260
5.	Harur	Melons	105
6.	Palacode	Tuberose	75
7.	Karimangalam	Brinjal, Chrysanthemum	45

** Source – Deputy Director of Horticulture, Dharmapuri district, Tamilnadu [13]*

3.6 Horizontal Spread of the Technology

The technology is being adapted in all the eight blocks of the Dharmapuri district. The crops under plastic mulching are not only Tuberose and Melons, but the farmers are adopting the technology for other crops also. Especially the farmers have well taken this in Chrysanthemum and Brinjal next to tuberose and melons. The percent adaption to the total area cultivated is given in the Table 7.

As farmers adopted this technology, Krishi Vigyan Kendra initiated the demonstration of the mulch sheet spreader under the IAMWARM project. Spreading of mulching sheet involves drudgery to the labours. Use of mulch sheet spreader reduced the drudgery involved. Mulch sheet spreader is five in one machinery which does formation of the raised bed, laying drip laterals at the centre of the raised bed, spreading of mulch sheet, earthing up and application of basal dose of fertiliser. By the demonstrations, farmers are made aware of the advantage of the use of mulch sheet spreader. The time, cost and labour saving by use of mulch spreader are realised by the farmers (Table 8). It is available at KVK for custom hiring farmers particularly from Morappur, Harur and Pappireddipatti blocks are utilising the mulch spreader.

Table 7. Percent adaption of plastic mulching to the total area cultivated

S. no	Crop	Total area (ha)	The area under mulching (ha)	Percentage of area under plastic mulching
1.	Tuberose	1400	200	14.30
2.	Watermelons	390	320	82.05
3.	Muskmelon	200	180	90.00
4.	Chrysanthemum	2000	20	1.00
5.	Brinjal	2500	15	0.60

** Source – Annual report, Department of Horticulture, Dharmapuri district, Tamilnadu (2016)*

Table 8. Comparison of use of mulch sheet spreader with manual spreading

S. no.	Parameters	Manual spreading	Mulch sheet spreader	Percentage saving
1.	Time taken (Hrs/ha)	40.0	5.0	12.5
2.	No. of labour	8	2	25.0
3.	Cost of spreading	5000	1200	24.0

4. CONCLUSION

Plastic mulching either directly or indirectly reduces the incidences of pest and diseases. This ultimately reduces pesticide spray towards the management of these pests to a tune of 40 – 60%. In melons the use of mulching helps the farmer to cultivate three or four crops continuously without any agronomic operations. Thus, zero tillage is practiced which ultimately helps to improve the soil health. The use of mulching reduces the use of herbicides for the management of weeds in these crops. The numbers of irrigations are reduced in the mulched field by 30 – 40 percent which varies with the crop. The economic benefits of the technology were realised by farmers.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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