Content list available at http://epubs.icar.org.in, www.kiran.nic.in; ISSN: 0970-6429

Indian Journal of Hill Farming

June 2022, Volume 35, Issue 1, Page 73-78

Efficient utilization of harvested rain water in *Jalkund* through gravity fed drip irrigation and mulching for higher productivity and quality of strawberry (*Fragaria x ananassa*) in mid- altitude of North East Indian Himalayas

Anup Das[1*] • P K Ghsoh[2*] • DJ Rajkhowa[3] • Juri Buragohain[4]

[1]Principal Scientist (Agronomy), ICAR Research Complex for NEH Region, Tripura Centre, Lembucherra, Tripura (anup.das2@yahoo.com)

[2] Director, National Institute of Biotic Stress Management, Raipur, Chhattisgarh

[3]Joint Director, ICAR Research Complex for NEH Region, Nagaland Centre, Jharnapani, Nagaland (djrajkhowa@gmail.com)

[4]Technical Officer, ICAR Research Complex for NEH Region, Umiam, Meghalaya (juri.bgohain@yahoo.com)

ARTICLE INFO

Article history:
Received: 01 April, 2022
Revision: 17 April, 2022
Accepted: 11 May, 2022

Key words: Berry quality, High value crops, Hill ecosystem Productivity, Rain water harvesting

ABSTRACT

A field study was conducted during winter seasons of three consecutive years (2009-10 to 2011-12) at Umaim, Meghalaya (950 m ASL) to study the effect of drip irrigation and mulching measures on the productivity and quality of strawberry (*Fragaria x ananassa* Duch) variety 'Festival'. Two types of mulches (plastic mulch and straw mulch) were used in the experiment with four gravity fed drip irrigation levels i.e., control, 0.8 Epan, 1.0 Epan and 1.2 Epan. Soil moisture content monitored (0-20 cm soil depth) during crop growing phases at 15 days intervals were found higher under plastic mulch and 1.2 Epan than other treatments. Among the mulches, plastic mulch recorded significantly higher berry yield (5.76 t/ha) over straw mulch (5.6 t/ha). The yield attributing parameters were also found to be higher under plastic mulch. However, the type of mulch material had minimal influence on the physicochemical parameters of fruits. Drip irrigation at 1.0 Epan combined with plastic mulch was found superior for higher yield and yield attributing parameters, specific gravity, juice density, juice percentage, ascorbic acid, anthocyanin and total sugar content in strawberry over the other levels of irrigation and mulching combination. Thus, irrigation at 1.0 Epan along with plastic mulching is recommended for higher productivity, water use efficiency and quality of strawberry at mid-altitude of north eastern Indian Himalayas.

1. Introduction

Strawberry (*Fragaria x ananassa* Duch), a member of Rosaceae family is a delicious soft fruit of great nutritional value. It is cultivated in various agro-ecological situations up to an altitude of 3000 meter (Sharma 2002). The fruit is aggregate and has a characteristic aroma and bright red colour. It is a rich source of vitamin C, minerals and antioxidants. It can be taken fresh or made into preserved products. Off late strawberry is gaining popularity in the state of Meghalaya, in north eastern Himalayas due to its favourable agro-climatic conditions and potential for livelihood improvement of tribal farmers (Singh *et al.* 2007). It is also popular in regions like Mahabaleswar (Maharastra), Solan and Kulu (Himachal Pradesh), Dehradun, Nainital and Joylikot (Uttaranchal), Darjeeling (West Bengal) and Hissar (Haryana) (Sharma and Yamdagni 2000).

Strawberry is a high water requiring crop and major constraint in strawberry cultivation in hills is the lack of irrigation facilities. Harvesting rain water at hills for its efficient utilization in high valued crop is a viable proposition (Saha *et al.* 2007). Harvested rain water is a precious natural resource and must be efficiently utilized preferably for high value crops (Das *et al.* 2017). Micro-irrigation has proved its efficiency and superiority over other conventional irrigation practices especially for high value horticultural crops owing to precise and direct application of water in root zone with

*Corresponding author: ghosh_pk2006@yahoo.com/ anup.das2@icar.gov.in

minimal or no conveyance loss (Singh *et al.* 20120). Strawbeery is a shallow rooted crop and requires frequent but less amount of water in each irrigation, which is most feasible through drip irrigation. Improvement in plant height, plant spread, leaf area, fruit weight and fruit yield of strawberry due to black polyethylene mulching relative to transparent polyethylene or paddy straw have been reported (Ravi *et al.* 2010). Considering above factors in mind, a field experiment was conducted for efficient utilization of harvested rain water in hill top in *Jalkund* (Micro rain water harvesting structure, 30000 L capacity, 250 GSM polyfilm lined) through different levels of drip irrigation and mulching. The hypothesis tested was that conservation of water in soil and efficient use of water would enhance productivity and quality of strawberry.

2. Materials and Methods

A field experiment was conducted during winter seasons of three consecutive years (2009-10 to 2011-12) at Water Management Farm (950 m ASL), ICAR Research Complex for NEH Region, Umiam, Meghalaya lying between 25° 41′ N and longitude of 91°′ 54′ E to study the effect of gravity fed drip irrigation levels and mulching on productivity and quality of strawberry. The experimental soil was low in N, very low in P and high in Potassium. The organic carbon content and pH of the soil were 17.6 g/kg and 5.7, respectively. The experimental area received an annual rainfall of about 2450 mm. During the experimental period (2009-12) a total annual rainfall of 2377.60 to 2829.30 mm were received. The average maximum and minimum temperature during the growth season were 26.35°C and 14.61°C respectively.

The runners of the variety 'Festival' were planted under double row hill system in open field conditions in the first week of October at a spacing of 45 x 30 cm in 20 cm raised beds. Rainwater harvested in *jalkund* at hill tops was used for irrigating the crops through gravitational flow. The dimension of the *jalkund* was 5 x 4 x 1.5 m lined with agri-film (Silpaulin 250 GSM) with a capacity of harvesting 30,000 litres rain water at a time. Four irrigation levels i.e. Control (Life saving irrigation), 0.8 Epan, 1.0 Epan and 1.2 Epan were used for irrigating the crop through drip system using gravitational flow. Required calibration was performed for irrigating the crops at different Epan levels. Two mulching treatments i.e., paddy straw (10 t/ha) and black polyethylene (50 GSM) were used.

Soil moisture was recorded at 15 days interval from 30 days after sowing (DAS) onwards up to 75 DAS. The growth, yield and quality parameters were recorded at harvest. The ripe fruits of strawberry were harvested from February to end of April. Soil moisture data was recorded in third year of the study from 0-20 cm depth through gravimetric method. Ten randomly selected fruits from each picking were analyzed during third year of the study for their physical and quality parameters such as number of berries/plant, berry weight (g), berry yield (t/ha), berry length (mm), berry breadth (mm), specific gravity, juice density (g/cc), juice %, TSS (°Brix), acidity content (%), ascorbic acid content (mg/100 g), anthocyanin content (mg/100 g) and total sugars content (%) were estimated following standard procedures. The total soluble solids (TSS) were determined by Erma Hand Refractometer and results were expressed in °Brix. The tritratable acidity (%) was determined by AOAC method (1980). The ascorbic acid content (mg/100 g) was determined by 2,6 dichlorophenol dye method (AOAC 1980). The anthocyanin content (mg/100 g) was determined by standard method described by Rangana (1994). The total sugar content was estimated by following the method of Lane and Eynonn (Rangana 1994).

The average data of three years were analysed as per the method of Gomez and Gomez (1984). The critical difference at 5% level of probability was used for testing the significant differences between treatment means.

3. Results and Discussion

Seasonal soil profile moisture status

The soil moisture content at 0-20 cm depth was generally higher under plastic mulch over straw mulch (Fig.1.). Among irrigation levels, the highest soil moisture content was recorded under irrigation at 1.2 Epan followed by 1.0 and 0.8 Epan. Little variation in soil moisture content during 45 DAS was mainly due to light rains received.

Yield and yield attributing factors

In general the yield and yield attributing factors were found to be higher under polythene mulch than straw mulch (Table 1, Fig 2). It is evident from the data presented in the table that the number of berries per plant under plastic mulching (19.24) was significantly higher than those under straw mulch (16.03). The irrigation level of 1.0 Epan produced significantly higher number of berries per plant (17.87 berries/plant) over other levels of irrigation , which was followed by 1.2 Epan (16.49 berries/plant), while number of berries/plant under control was the lowest (14.00). The berry weight was also significantly higher under the plastic mulching (182.12 g/plant) over the straw mulching (171.13 g/plant). Among the different levels of irrigation, significant variations were found in terms of berry weight/plant with 1.0 Epan recording maximum value (180.84 g/plant), followed by 1.2 Epan (167.64 g/plant). The minimum berry weight (136.40 g/plant) was observed under control . In terms of berry yield, the effect of plastic mulch was found to be more positive over straw mulch. Plastic mulching had significantly higher beery yield (5.76 t/ha), in relation to straw mulching (5.60 t/ha). Kher *et al.* (2010) also reported a higher yield of

strawberry with black polythene mulch over other mulching practices. The influence of different levels of irrigation was profound on the berry yield. Drip irrigation at 1.0 Epan had the most positive influence on the berry yield with a yield of 5.40 t/ha, which was closely followed by 1.2 Epan recording 5.35 t/ha of berry yield. Again the fruit yield under control was the lowest (4.57 t/ha). Plastic mulching also recorded significantly higher value of berry length (38.32 mm) over straw mulch (37.88 mm). However, for berry breadth there was no significant effect of the type of mulch material used with plastic mulch recording slightly higher value (31.55 mm) over straw mulch (31.36 mm).

The effects of different levels of irrigation were found significant on both berry length and berry breadth. The highest values of berry length (35.53 mm) and berry breadth (29.44 mm) were obtained under 1.0 Epan, which were closely followed by 1.2 Epan with a berry length of 34.04 mm and breadth of 29.07 mm. Fruits in the control treatment recorded the lowest values for berry length (32.42 mm) and berry breadth (26.18 mm). These variations in yield and yield attributing parameters in the same cultivar is because of the different mulching material and the different levels of irrigation used which had favourable effect on the growth. The yield parameters were found to be higher under 1.0 Epan which was closely followed by 1.2 Epan indicating the need for providing adequate water to the crop. Excess water above 1.0 Epan is a waste especially under mulching. Similar results were also reported by Sharma *et al.* (2005) who found that berry yield was significantly higher under the drip irrigation at 100 per cent of evaporation + black polyethylene mulch whereas, the lowest yields were recorded under non-irrigated rainfed unmulched treatment. Mulches like polythene and straw mulch are reported to be effective in regulating soil hydrothermal regimes which provides a favorable environment for root growth, nutrient uptake and finally higher yields (Raina *et al.* 2004).

Physico-chemical properties

The physicochemical parameters of berries (Tables 2 & 3) were less influenced by the type of mulch material used with plastic mulch recording slightly higher values over straw mulch. However, the different levels of irrigation had significant effect on most of the parameters. For specific gravity, fruits under plastic mulch recorded a value of 20.58, which was significantly higher than that under straw mulch (19.46). The different levels of irrigation did not have any significant effect on specific gravity of the fruits with 1.0 Epan recording the maximum specific gravity of 20.04 and control fruits recording the lowest specific gravity of 17.47. Fruits under plastic mulch recorded a juice density of 0.67 g/cc, while those under straw mulch had a value of 0.66 g/cc. Similarly, fruits under 1.0 Epan irrigation gave the maximum juice density of 0.61 g/cc, which was significantly higher over other treatments, whereas fruits under control had the lowest juice density of 0.57 g/cc. As regards to juice percentage, plastic mulching gave a higher value (71.87%) over straw mulch (71.76%). Among the different levels of irrigation, the most significant effect on juice percentage was obtained for irrigation at 1.0 Epan with a value of 64.47%, which was followed by irrigation at 1.2 Epan with 63.88%. Fruits under control had the lowest juice percentage with a value of 63.31%.

The TSS concentration was significantly influenced by the mulching treatments. Plastic mulching gave the highest TSS of 9.50 (°Brix) closely followed by straw mulch (9.47 °Brix). The TSS was also significantly affected by the different levels of irrigation used. The fruits under 0.8 Epan had the highest TSS of 8.51 (°Brix), which was closely followed by 1.0 Epan fruits with a TSS of 8.50 (°Brix). The fruits under control had the lowest TSS of 8.29 (°Brix). For acidity content, straw mulching gave a slightly higher value

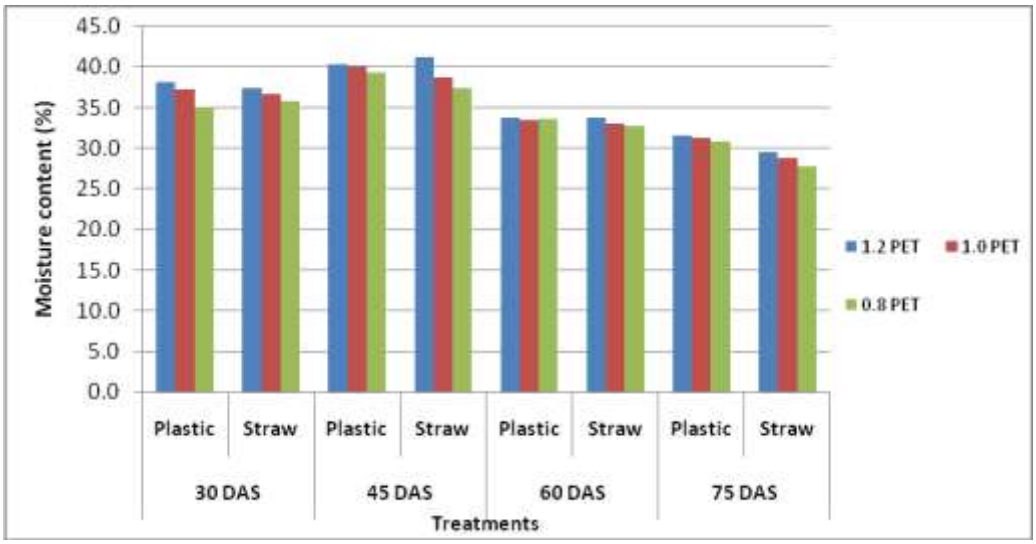

Figure 1. Soil moisture content (%) in 0-20 cm under different treatments

of 0.65% over plastic mulch (0.64%). Again, the different levels of irrigation had significant effect on the acidity content with the fruits under control giving the highest value of 0.59% and 0.8 Epan and 1.2 Epan recording the lowest value of 0.56%. The higher acidity content of the control fruits may be because of less water and nutrients available to the plants. The ascorbic acid content obtained for plastic mulch was 78.91 mg/100g and for straw mulch the value was 78.78 mg/100g. Ascorbic acid content was significantly affected by the different levels of irrigation used. The highest ascorbic acid content among the different levels of irrigation was obtained for 1.0 Epan with a value of 71.06 mg/100g, whereas the lowest ascorbic acid content of 69.11 mg/100g was recorded for control fruits. The fruits under plastic mulching gave a higher anthocyanin content of 94.79 mg/100g over straw mulch with a value of 94.31 mg/100g. The different levels of irrigation significantly affected the anthocyanin content of the fruits with 1.0 Epan treated fruits recording the highest anthocyanin content of 87.24 mg/100g, which was closely followed by 1.2 Epan with 86.50 mg/100g. The fruits under control had the lowest anthocyanin content of 78.04 mg/100g. As regards to total sugar content, plastic mulch recorded a value of 7.21% over straw mulch which recorded a total sugar content of 7.19%. Again the different levels of irrigation significantly affected the total sugar content of the fruits which was found to be highest for the fruits under 1.0 Epan recording a value of 6.46%, followed by 0.8 Epan with a total sugar content of 6.44%, whereas the fruits under control recorded a lowest total sugar content of 6.31%. Mulching along with irrigation provided better moisture conservation, optimum soil temperature and nutrient supply to the crop which resulted in higher nutritional quality of the fruits. Similar results were also reported by Kumar *et al.* (2005). Higher yields under black polythene mulch may be ascribed to weed control and moisture conservation (Singh *et al.* 2012).

Based on the above experiment, it was evident that the integrated use of plastic mulch along with drip irrigation at 1.0 Epan is most efficient in improving yield and quality parameters of strawberry fruits in north eastern Himalayas. Drip irrigation also proved to be an effective method for utilization of harvested rainwater for high value crops.

4. Acknowledgements

The authors are thankful to the Director, ICAR Research Complex for NEH Region, Umiam, Meghalaya and the ICAR-IIWM, Bhubaneswar for providing necessary support to carry out the study under ICAR-AICRP on Water Management, Shillong Centre, Meghalaya.

5. References

AOAC, 1980. *Official Methods of Analysis*. Association of Official Analytical Chemists, Washington DC, USA.

Das A, Singh RK, Ramkrushna GI, Layek J, Tripathi AK, Ngachan SV, Choudhury BU, Patel DP, Rajkhowa DJ, Chakroborty D and Ghosh PK (2017). Roof water harvesting in hills- innovations for farm diversification and livelihood improvement. Current Science. 113 (2): 292-298

Gomez AA and Gomez KA (1984). *Statistical Procedures for Agricultural Research*, PP 680. John Wliey and Sons, Inc., New York.

Kher R, Baba JA and Bakshi P (2010). Influence of planting time and mulching material on growth and fruit yield of strawberry cv. Chandler. Indian Journal of Horticulture. 64(4): 441-444

Kumar S, Sharma IP and Raina JN (2005). Effect of levels and application methods of irrigation and mulch material on strawberry production in North – West Himalayas. Journal of the Indian Society of Soil Science. 53 (1): 60 – 65.

Raina JN, Thakur BC and Sephia R (2004). Effect of mulches on soil Hydrothermal regimes, root growth, yield and quality of strawberry. Annals of Plant and Soil Research. 12 : 6-30.

Rangana S (1994). *Handbook of Analysis and Quality Control for Fruits and Vegetable Products*. 2nd Edition, Tata McGraw Hill Publication Co. Ltd, New Delhi.

Saha R, Ghosh PK, Mishra VK and Bujarbaruah KM (2007). Low-cost micro rainwater harvesting technology (Jalkund) for new livelihood of rural farmers. Current Science. 92(9): 1258-1265.

Sharma R R (2002). *Strawberry*. International Book Distributing Co., Lucknow.

Sharma RM and Yamdagni R (2000). *Modern Strawberry Cultivation*, PP.172, Kalyani Publishers, New Delhi.

Sharma IP, Kumar S and Kumar P (2005). Effect of drip irrigation and mulches on yield, quality and water-use efficiency in strawberry under mid hill conditions. Acta Horticulturae. (Ishs) 696:259-264.

Singh AK, Singh SK, Pandey AK, Rajan K and Kumar A. (2012). Effects of drip irrigation and polythene mulch on productivity and quality of strawberry (*Fragaria ananassa*). HortFlora Research Spectrum, 1(2): 131-134.

Singh A, Patel RK, De LC and Pereira LS (2007). Performance of strawberry (Fragaria x ananassa) cultivars under sub-tropics of Meghalaya. Indian Journal of Agricultural Sciences. 78 (7): 575-80.

Figure 2. Overview of experimental plot

Table 1. Effect of irrigation levels and mulching on yield parameters and yield of straw berry (three years pooled data)

Treatments	No. of berries/plant	Berry Weight (g/plant)	Berry Yield (t/ha)	Berry Length (mm)	Berry Breadth (mm)
Plastic Mulch	19.24	182.12	5.76	38.32	31.55
Straw Mulch	16.03	171.13	5.60	37.88	31.36
CD (*P = 0.05*)	0.24	1.94	0.15	0.14	NS
SEm(±)	0.06	0.49	0.04	0.03	0.23
Irrigation levels (PET)					
Control	14.00	136.40	4.57	32.42	26.18
0.8	14.36	143.11	4.87	33.47	27.14
1.0	17.87	180.84	5.40	35.53	29.44
1.2	16.49	167.64	5.35	34.04	29.07
CD (*P = 0.05*)	0.38	2.76	0.18	0.44	0.38
SEm (±)	0.13	0.93	0.06	0.15	0.13
M x I					
CD (*P = 0.05*)	0.66	4.77	0.31	NS	NS
SEm (±)	0.22	1.61	0.10	0.26	0.22

Table 2. Effect of irrigation levels and mulching on physico-chemical parameters of straw berry (three years pooled data)

Treatments	Sp. gravity	Juice density (g/cc)	Juice %	TSS (°Brix)
Plastic Mulch	20.58	0.67	71.87	9.50
Straw Mulch	19.46	0.66	71.76	9.47

CD (P = 0.05)	NS	NS	NS	NS
SEm(±)	4.84	0.003	0.13	0.01
Irrigation levels (PET)				
Control	17.47	0.57	63.31	8.29
0.8	18.04	0.59	63.68	8.51
1.0	20.04	0.61	64.47	8.50
1.2	17.82	0.60	63.88	8.42
CD (P = 0.05)	NS	0.01	0.84	0.13
SEm (±)	2.11	0.005	0.28	0.04
M x I				
CD (P = 0.05)	NS	NS	NS	NS
SEm (±)	3.66	0.01	0.31	0.07

Table 3. Effect of irrigation levels and mulching on physicochemical parameters of straw berry (three years pooled data)

Treatments	**Acidity (%)**	**Ascorbic acid (mg/100g)**	**Anthocyanin (mg/100g)**	**Total sugars (%)**
Plastic Mulch	0.64	78.91	94.79	7.21
Straw Mulch	0.65	78.78	94.31	7.19
CD (*P = 0.05*)	NS	NS	NS	NS
SEm(±)	0.01	0.07	0.20	0.06
Irrigation levels (PET)				
Control	0.59	69.11	78.04	6.31
0.8	0.56	69.76	84.30	6.44
1.0	0.57	71.06	87.24	6.46
1.2	0.56	70.40	86.59	6.40
CD (*P = 0.05*)	0.02	0.57	1.58	0.12
SEm (±)	0.006	0.19	0.53	0.04
M x I				
CD (*P = 0.05*)	NS	NS	NS	NS
SEm (±)	0.008	0.33	0.92	0.07