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Effect of Spacing and Mulch on Post Harvest Disease Incidence and Sensory Evaluation in Strawberry

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To study the response of plant spacing and mulch material on post harvest disease incidence and sensory evaluation in Strawberry.
Study Design: The investigation was laid in a factorial randomized block design.
Place and Duration of Study: Sample: Farmer's field in Dhankhuloi village of Jorhat district,Assam and Department of Horticulture,Assam Agricultural University,Jorhat,India, during November-April of two consecutive years 2019-20 and 2020-21.
Methodology: We included twenty treatments which were the combination of five spacings viz. 20 cm x 30 cm, 30 cm x 30 cm, 30 cm x 40 cm, 40 cm x 40 cm and 40 cm x 60 cm with four mulch materials i.e. paddy straw,red mulch,silver black mulch and no mulch. Evaluation of percent post harvest disease incidence and organoleptic qualities was conducted.
Results: Out of 20 treatments, the treatment combination of widest spacing 40 cm x 60 cm along with silver black mulch showed least percent postharvest disease incidence (18.90%) while maximum incidence (42.82%) was obtained in no mulch applied plots with 20 cm x 30 cm spacing. Sensory evaluation showed treatment combination of 40 cm x 40 cm spacing with silver black mulch exhibited better organoleptic qualities.

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Conclusion: Positive effects of wider spacing and silver black mulch material might have contributed to least post harvest disease incidence in strawberry. Fruits of strawberry mulched with silver black plastic and wider spacing owing to favourable microclimate may have contributed to a sweeter taste and, consequently, better consumer acceptance.

Keywords: Strawberry; spacing; mulch; postharvest disease incidence; sensory evaluation.

1. INTRODUCTION

Strawberry has commanded a premier position in the world fruit market due to its attractive fruit and pleasant distinctive flavor. It has adapted well to highly varying climatic conditions. Strawberry cultivation recently received some impetus in India and has become very popular among the farming community due to earlier and higher prices [1]. However,the growers do not seem to adopt proper agronomic practices due to various reasons.Adopting optimum plant spacing and mulch material can help farmers earn more prices in the market.Optimum plant spacing facilitates better plant growth and development thereby maximizing yield and efficient utilization of land [2]. Mulches are materials applied over the soil surface which helps in weed suppression, soil moisture conservation and modifying soil temperature. The strawberry fruits lying on the ground come in contact with soil making the fruits dirty and susceptible to soil-borne pathogen infections, leading to reduced fruit quality. This is an additional advantage of using mulches in strawberry production by reducing the number of diseased and dirty berries [3]. However, no work has been done on the effect of plant spacing and mulch on percent post harvest disease incidence and sensory evaluation of strawberry under Jorhat condition and hence the present study has been undertaken.

2. MATERIALS AND METHODS

A field investigation was carried out at farmers' field in Dhankhuloi village of Jorhat district of Assam,India during the consecutive years 2019-2020 and 2020-21 to study the effect of spacing and mulch material on percent post harvest disease incidence and quality of Strawberry fruit . Three replications laid out in a Factorial Randomized Block Design (FRBD). The treatments comprised of five various spacing viz., S1 -20 cm x 30 cm, S2- 30cm x 30 cm, S3 -30 cm x 40 cm, S4 -40 cm x 40 cm, S5 -40 cm x 60 cm and four mulch materials i.e. M1-paddy straw,M2-red mulch,M3-silver black mulch and M4- no mulch. The experimental plot was brought to fine tilth by ploughing, clod crushing and harrowing and vermicompost @ 2.5 t ha^{-1} was mixed uniformly in the soil during bed preparation. No fertilizers were applied; foliar spray of NPK 19-19-19 @ 5g per litre was applied at ten days interval along with micronutrients. Percent post harvest disease incidence mainly gray mould were recorded in the laboratory by using the formula as mentioned by Kuyu and Tola [4]; and the data was statistically analyzed using SPSS software.The organoleptic characteristics of the strawberry fruits viz. firmness, colour, flavour and sweetness were tested at harvest by sensory evaluation carried out with the help of a sensory panel of judges using a 5 point hedonic scale and fruits with score above 3.0 was considered acceptable [5].

3. RESULTS AND DISCUSSION

3.1 Percent Post Harvest Disease Incidence

The data presented in Table 1 and Fig.1 revealed that, different spacing and mulch treatment combination had significant effect on percent post harvest disease incidence mainly gray mould in strawberry.The strawberry has excellent sensory characteristics but it is highly perishable, with limited postharvest life due to high moisture content, sugars and acids, therefore making it an ideal substrate for proliferation of pathogenic organisms that cause considerable postharvest damage. The pathogens *Botrytis cinerea*, followed by *Rhizopus stolonifer*, *Colletotrichum* spp *Mucor* spp., are mainly responsible for postharvest diseases of strawberry fruit. *Botrytis cinerea* is the causal organism of Gray mould which can cause infection before harvest, in the field stage and stays dormant in storage, till the conditions become favourable for their development.

During the first year, 2019-20, least per cent post harvest disease incidence (26.92 %) was recorded in S5 and statistically similar with S4 (27.37%) while highest per cent disease incidence was observed in S1 (30.79 %).During

the second year, 2020-21, least per cent post harvest disease incidence (27.93 %) was recorded in S5 and statistically similar with S4 (28.22 %) while highest per cent post harvest disease incidence was observed in S1 (31.91%).

The combined analysis of both years data further revealed that the percent post harvest disease incidence was noted significantly least (27.42%) with wider spacing of 40 cm x 40 cm whereas the maximum (31.35%) was recorded with the closest spacing of 20 cm x 30 cm. This might be attributed to the fact that proper plant spacing helps to prevent the development of foliar diseases; because wider rows improve wind penetration to reduce humidity through the crop canopy, thus making the environment suboptimal for disease infestation Similar views were expressed by Brar et al.,[6] in their study.

Table 1. Effect of spacing and mulch and their interaction on percent post harvest disease incidence

Treatment	Post harvest disease incidence (%)		
	2019-2020	2020-21	Pooled
Spacing (S)			
20 cm x 30 cm (S1)	30.79[c]	31.91[c]	31.35[c]
30 cm x 30 cm (S2)	29.47[b]	30.63[b]	30.05[b]
30 cm x 40 cm (S3)	29.07[b]	30.28[b]	29.67[b]
40 cm x 40 cm (S4)	27.37[a]	28.22[a]	27.79[a]
40 cm x 60 cm (S5)	26.92[a]	27.93[a]	27.42[a]
SEd(±)	0.41	0.46	0.31
CD(P=0.05)	0.83	0.94	0.62
Mulches (M)			
Paddy straw(M1)	31.24[c]	32.32[c]	31.78[c]
Red mulch(M2)	21.54[b]	22.85[b]	22.20[b]
Silver Black mulch (M3)	20.76[a]	21.99[a]	21.37[a]
No mulch(M4)	41.36[d]	42.00[d]	41.69[d]
SEd(±)	0.36	0.41	0.28
CD(P=0.05)	0.74	0.84	0.55

Table 1. Continued

Interaction (S x M)	Post harvest disease incidence (%)						
Treatment combination	**2019-20**	**2020-21**	**Pooled**	**Treatment combination**	**2019-20**	**2020-21**	**Pooled**
T_1 (S1M1)	33.33	34.55	33.94	T_{11} (S3M3)	21.25	22.95	22.10
T_2 (S1M2)	24.15	25.48	24.81	T_{12}(S3M4)	41.34	41.89	41.61
T_3 (S1M3)	23.28	24.40	23.84	T_{13}(S4M1)	30.46	31.51	30.98
T_4 (S1M4)	42.41	43.22	42.82	T_{14}(S4 M2)	19.32	20.36	19.84
T_5 (S2 M1)	31.82	32.44	32.13	T_{15}(S4 M3)	18.80	19.46	19.13
T_6 (S2 M2)	22.52	24.11	23.32	T_{16}(S4 M4)	40.89	41.56	41.22
T_7 (S2 M3)	21.92	23.90	22.91	T_{17}(S5 M1)	29.30	30.75	30.03
T_8 (S2 M4)	41.63	42.07	41.85	T_{18}(S5 M2)	19.29	20.40	19.85
T_9 (S3 M1)	31.29	32.36	31.82	T_{19}(S5 M3)	18.55	19.25	18.90
T_{10}(S3M2)	22.42	23.91	23.16	T_{20}(S5 M4)	40.56	41.29	40.93
	2019-20			**2020-2021**	**Pooled**		
SEd(±)	0.82			0.93	0.62		
CD(P=0.05)	NS			1.88	1.23		

- *Superscript by same letter means they are at par*

During the first year, 2019-20, the least percent post harvest disease incidence (20.76 %) was recorded in M3 and followed by M2 (21.54 %) while M4 (41.36 %) reported highest per cent disease incidence. During the first year, 2020-21, the least percent post harvest disease incidence (21.99 %) was recorded in M3 and followed by M2 (22.85 %) while M4 (42.00 %) reported highest per cent disease incidence.

Pooled analysis of both year data revealed that minimum post harvest disease incidence (21.37%) was observed under silver black mulch whereas maximum (41.69%) was recorded under no mulch treatments. It might be due to the fact that the use of plastic mulch may cause less humid surroundings for the plants and, hence, less incidence of Botrytis. Minimum botrytis fruit rot infection observed in plants under silver black polyethylene and maximum in bare soil followed by paddy straw, mainly because straw is favourable medium for spread of *Botrytis cinerea*.The results are in agreement of Kumar et al.,[7] and Sharma et al.,[8].

The data from the interaction effect of spacing and mulch revealed that treatment combination T_{19} (40 cm x 60 cm with silver black mulch) recorded least per cent post harvest disease incidence (18.90 %) in the study. During the entire period of study,the percent disease incidence mainly gray mould observed irrespective of the treatments could be attributed by presence of disease causing inoculums due to favourable environmental conditions.

3.2 Sensory Evaluation

The fruits of different treatments were subjected to sensory evaluation for evaluating firmness, skin colour, pulp colour, flavour and sweetness are presented in Table (2).

The highest numerical rating with respect to firmness (Hedonic scale rating 4.14), skin colour (4.42), pulp colour (4.28), flavour (3.57), sweetness (3.71) was observed under treatment combination T_{15} (40 cm x 40 cm spacing with silver black mulch) having good overall acceptability. The numerical rating was lowest with respect to firmness (3.28), skin colour (3.28), pulp colour (2.28), flavour (2.00), sweetness (1.85) were recorded in T_{17} (40 cm x 60 cm spacing and paddy straw) giving acceptability score of 2.53 and T_{12} (30 cm x 30 cm with no mulch) giving score of 2.93 and both had the overall acceptability below 3.

The better organoleptic qualities under wider spacing could be due to fact that sufficient sunlight under wider spacing might have led to better conversion of starch to sugar as observed by Anil [9]. The better organoleptic traits under plastic mulch treatment could be due to more reflection of photosynthetically active radiation (PAR) into fruiting zone which elevated sugar conversion in agreement with views of Dhanush et al. [10].

In the study, the panel gave at par ratings to the samples for acceptance of the external appearance,

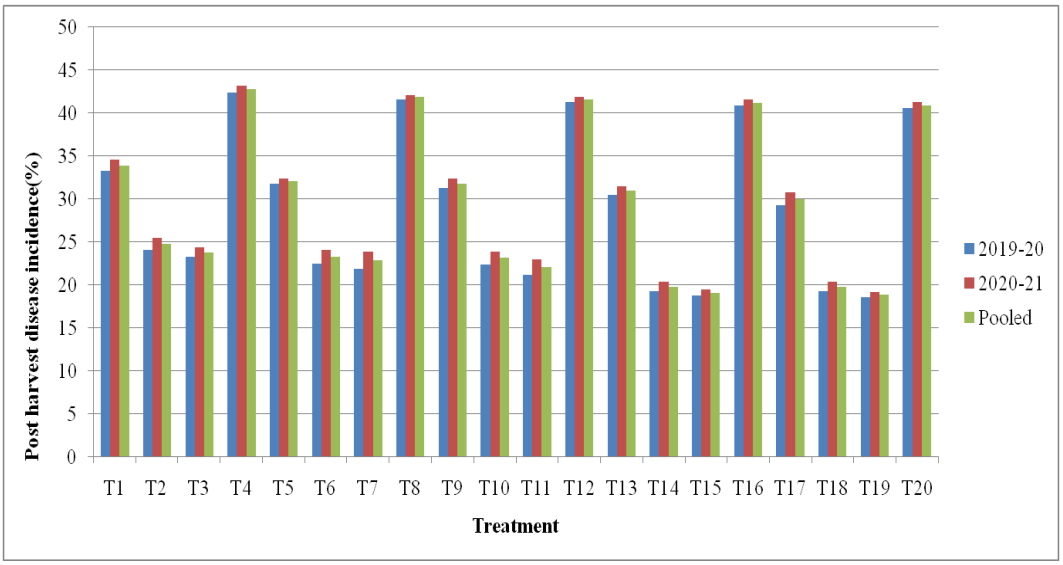

Fig. 1. Effect of spacing and mulch on percent post harvest disease incidence

Table 2. Effect of spacing and mulch interaction on Sensory evaluation

Treatment combination	Sensory evaluation rating					
	Firmness	Skin colour	Pulp colour	Flavour	Sweetness	Average
T_1 (S1M1)	3.71	3.85	2.57	2.85	2.71	3.13
T_2 (S1M2)	3.42	4.42	3.71	3.85	3.57	3.79
T_3 (S1M3)	3.71	4.42	3.57	3.57	3.57	3.77
T_4 (S1M4)	3.57	4.57	3.71	3.42	3.28	3.71
T_5 (S2 M1)	3.85	4.28	3.28	3.42	2.85	3.53
T_6 (S2 M2)	3.85	4.71	3.71	3.42	3.14	3.76
T_7 (S2 M3)	3.42	4.14	3.57	3.57	2.42	3.42
T_8 (S2 M4)	3.57	4.00	3.71	3.42	3.14	3.56
T_9 (S3 M1)	3.57	3.57	3.57	3.14	3.42	3.45
T_{10}(S3M2)	3.85	4.71	4.00	3.42	3.42	3.88
T_{11} (S3M3)	3.85	3.71	3.14	3.00	2.71	3.28
T_{12}(S3M4)	3.42	3.28	2.57	3.00	2.42	2.93
T_{13}(S4M1)	3.42	3.57	3.00	3.71	3.42	3.42
T_{14}(S4 M2)	3.85	4.00	3.14	3.14	3.00	3.42
T_{15}(S4 M3)	4.14	4.42	4.28	3.57	3.71	4.02
T_{16}(S4 M4)	3.85	4.00	3.57	3.28	3.14	3.56
T_{17}(S5 M1)	3.28	3.28	2.28	2.00	1.85	2.53
T_{18}(S5 M2)	3.71	3.85	3.85	3.57	3.14	3.62
T_{19}(S5 M3)	3.00	4.28	3.71	3.14	2.42	3.31
T_{20}(S5 M4)	3.85	4.42	4.00	3.14	3.00	3.68

indicating that the consumers would accept better sample, despite differences in physical characteristics. The average hedonic value,however, did not always faithfully represent the opinions of the judges as a group as opined by Amorim et al. [11].

4. CONCLUSION

The study revealed that the optimum spacing and appropriate mulch material had a substantial impact on post harvest disease incidence and sensory evaluation of strawberry. The results indicate that fruits grown under T_{19}(40 cm x 60 cm spacing with silver black mulch) had least percent post harvest disease incidence while T_{15}(40 cm x 40 cm spacing with silver black mulch) better organoleptic qualities.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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