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Effect of various mulching material on vegetative growth, flowering and fruiting attributes of strawberry (*Fragaria* x *ananassa* Duch.) cv. winter dawn

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Abstract
A Research entitled "Effect of various mulching material on vegetative growth, Flowering and fruiting attributes of strawberry (*Fragaria* x *ananassa* Duch.) cv. Winter Dawn." was carried out at the Research Farm of the Department of Horticulture at Sam Higginbottom University of Agriculture, Technology & Sciences in Prayagraj (U.P.), during the academic years of 2020–2021 and 2021–2022. Eleven treatments using various mulching materials were tested in a Randomised Block Design with three replicates. Treatments were namely T_1 Control (Without Mulching), T_2 Wheat straw (5 t/ha), T_3 Paddy straw (5 t/ha), T_4 Coconut husk (5 t/ha), T_5 Paddy husk (5 t/ha), T_6 Saw dust (5 t/ha), T_7 Cut grass (5 t/ha), T_8 Green polythene (200 gaze), T_9 Blue polythene (200 gaze), T_{10} Transparent polythene (200 gaze), T_{11} Black polythene (200 gaze). The experiment's primary objective was to determine the effect of various mulching material on the vegetative growth and flowering, fruiting traits of strawberry cv. Winter dawn. According to the findings of this study, application of treatment T_{11} Black polythene (200 gaze) proved to be most effective mulching material to increase plant height, no. of leaves, plant spread, early flowering and maximum no. of strawberries.

Keywords: Strawberry, mulching, vegetative growth, flowering and fruiting attributes

Introduction
Strawberry (*Fragaria* × *ananassa* Duch.) is one of the most important temperate fruit which can also be grown in tropical and sub-tropical climate with limited efforts. It is very much liked for its attractive shape, distinct pleasant aroma and refreshing nature (Ali and Gaur, 2007) [3]. Strawberry is amongst the few crops, which gives quick and very high returns per unit area on the capital investment, as the crop is ready for harvesting within six months of planting. It is an important soft fruit after grape and being preferred by the people around the world due to its attractive colour, pleasant flavor and aroma. Botanically strawberry fruit is termed as aggregate fruit called etaerio of achenes. It requires a well-drained medium loam soil, rich in organic matter. Soil should be slightly acidic with pH from 5.7-6.5. Temperate climate is ideal for strawberry cultivation. Generally, in between 10-25 °C temperature is supportive for this crop. Retentive power of flower commences on minimum 15 °C and it sluggish after more than 37 °C. In winter season plant do not make growth and remains dormant, when day becomes longer in spring with rise in temperature the plant resume growth and flowering. The last decade has witnessed the emergence of strawberriesy as the leading fruit in the category of soft berries. The area and production under strawberry in the world has increased logarithmically during the last two decades as much of the crop is being grown under protected structures. In India, strawberry is cultivated on a commercial scale in the states of Maharashtra, Punjab, Haryana, Delhi, parts of Himachal Pradesh, Jammu & Kashmir, Uttarakhand, Uttar Pradesh, West Bengal (Darjeeling hills) and Rajasthan (Rana and Chandel, 2003) [34]. Strawberry cultivation In Himachal Pradesh is in its infancy and has gained momentum in the recent past (Thakur and Shylla 2018) [41]. Mulching is an important cultural practice followed in strawberry. Besides conserving the soil moisture, mulching also improves growth and fruit quality of strawberry (Hassan *et al*., 2000) [15]. Different types of organic and inorganic mulches are used. Organic mulches are derived from plant and animal materials. The most frequently used organic mulches include plant residues such as straw, hay, peanut hulls, leaf mold compost, wood products such as sawdust, wood chips and shavings, and animal manures.

Organic mulches such as straw vetch providing environmental benefits such as increased nitrogen, recycling of nutrients, weed emergence, reduced soil erosion, addition of organic matter to the soil, reducing soil temperature during hot summer days and acting as a slow-released fertilizer (Abdul-Baki and Teasdale, 1993) [1]. Straw is primarily used in conjunction with matted row systems, which are widespread among growers in climates with cold winters and short summers. Normally, cut wheat straw is placed between rows after flowering and cultivated into the soil after harvest. Plastic mulch is often combined with annual hill systems, where strawberries are planted on raised beds. Those systems are predominant in climates with mild winters and warm summers (Hancock, 1999) [16]. Polythene mulches play a vital role in strawberry cultivation as it helps in conserving moisture, controlling weeds, regulating hydrothermal regimes and protecting the delicate fruits from direct contact with the soil (Hancock, 1999 [16]. and Sharma, 2009) [35]. Mulches reduce soil evaporation and increase yield through increasing water use efficiency (Adekalu, 2006) [2]. The soil under plastic mulch remains loose, friable and well-aerated. Roots have access to adequate oxygen and microbial activity is enhanced. Soil mulching with plastic film is very beneficial because cucurbits, watermelon being one of them are very shallow rooting and do not like being hoed (Messiaen, 1992) [23] and (Dadheech, 2018) [9].

Material and Methods

The experiment was carried out during 2020-21 and 2021-22 on crop research farm of Department of Horticulture, Naini Agricultural Institute, Allahabad, India. The area is located approximately six kilometers south of Prayagraj, on the right bank of the Yamuna River along the South of Rewa Road. It is located at 25024'23" north latitude, 81050'38" east longitude, and 98 metres (MSL) above sea level. The experiment was setup in a randomized block design (RBD) with 11 treatments and three replications namely T_1 Control (Without Mulching), T_2Wheat straw (5 t/ha), T_3 Paddy straw (5 t/ha), T_4 Coconut husk (5 t/ha), T_5 Paddy husk (5 t/ha), T_6Saw dust (5 t/ha), T_7 Cut grass (5 t/ha), T_8 Green polythene (200 gaze), T_9 Blue polythene (200 gaze), T_{10} Transparent polythene (200 gaze), T_{11} Black polythene (200 gaze).

Preparation and cultural practices of Experimental field:

For research purpose the field was deep ploughed by the Disk harrow before one week of transplanting. Removal of weeds and levelling of field was done in the next 2-3 days. Research field was divided in to 33 small plots of 2×1m dimensions with 30 cm of bunds. 50 cm width of irrigation channels were kept between two rows of plots.

For the recommended dose of NPK, FYM and DAP were applied in the field according to the treatments. Before the transplanting, basal dose were applied and mixed well in the soil and rest of doses were applied at the time of plant's requirement. Mulching materials were applied on prepared raised bed before transplanting.

A spacing of 45×30 cm between row to row and plant to plant in each plot respectively were maintained. Strawberry runners were transplanted accordingly. In each plot there were 12 plants transplanted. After the transplanting a light irrigation were provided to the plants.

Results and Discussion

The observations related to vegetative growth and flowering, fruiting parameters like Plant height, No. of leaves, plant spread, No. of runners, Days to first flowering, No. of fruits, Fruit length and Fruit width were observed after the harvesting of fruits and the data regarding that parameters are given below:

Plant height (cm)

The data presented in Table 1. clearly depict the significant effect of mulching material on plant height. The maximum plant height was recorded in treatment T_{11} Black polythene (13.94 cm) which was found at par with T_5 Paddy husk (13.45 cm), whereas minimum plant height was noted in the treatment T_1 Without mulch (7.88 cm) during first year at 120 Days. In the second-year treatment T_{11} Black polythene (14.33 cm) again showed maximum plant height which was found at par with T_5 Paddy husk (13.35 cm), while minimum plant height was noted in the treatment T_1 Without mulch (8.0 cm) at 120 days.

The pooled data of two year also revealed the maximum plant height in the treatment T_{11}Black polythene (14.14 cm) which was found at par with T_5 Paddy husk (13.40 cm). The minimum plant height was recorded in the treatment T_1 Without mulch (7.94 cm). The increase in growth parameters was attributed to sufficient soil moisture near root zone and minimized the evaporation loss due to mulching. The extended retention of moisture and availability of moisture also leading to higher uptake of nutrient for proper growth and development of plants, resulted higher growth of plant as compared to control. The changes in soil temperature below plastic mulch could be attributed to different manners of heating and heat transfer to soil and also to heat accumulation during day and loss during night. Similar findings have also been obtained by Deanban *et al.*, (2004) [11]., Ansary and Roy (2005) [6] in watermelon.

Number of Leaf

The perusal of data in Table 1. clearly indicates significant effect of mulching material on number of Leaf. The highest number of Leaf was observed in treatment T_{11} Black polythene (18.31), followed by T_5: Paddy husk (16.75), and lowest number of Leaf was noted in the treatment T_1 Without mulch (11.23) during first year at 120 days. In the second-year treatment T_{11} Black polythene (19.21) again showed maximum number of Leaf, followed by T T_5 Paddy husk (17.25) and minimum number of Leaf was noted in the treatment T_1 Without mulch (10.80).

The mean of two year also revealed the maximum number of Leaf at 120 Days in the treatment T_{11} Black polythene (18.75) followed by T_5 Paddy husk (16.99). The minimum number of Leaf was recorded in the treatment T_1 Without mulch (11.02). The extended retention of moisture and availability of moisture also leading to higher uptake of nutrient for proper growth and development of plants, resulted higher growth of plant as compared to control. The changes in soil temperature below plastic mulch could be attributed to different manners of heating and heat transfer to soil and also to heat accumulation during day and loss during night. Similar findings have also been obtained by Deanban *et al.*, (2004) [11], Ansary and Roy (2005) [6] in watermelon, Al Majali and Kasrawi (1995) [4] in Muskmelon and Alemayehu-Ambaye and Joseph (2002) [5] in melon.

Plant Spread (cm^2)

The effect of mulching material on plant spread presented in Table 1. States that the maximum value of plant spread was observed in the treatment in treatment T_{11} Black polythene (39.15 cm) followed by T_4 Coconut husk (38.00 cm), and minimum plant spread was noted in the treatment T_1 Without mulch (27.52 cm) during the first year. In the second-year treatment T_{11} Black polythene (40.04 cm) again showed maximum plant height followed by T_4 Coconut husk (39.81 cm), and minimum plant spread was noted in the treatment T_1 Without mulch (26.97 cm).

The pooled data of two year also revealed the maximum plant spread in the treatment T_{11} Black polythene (39.58 cm) which was found at par with T_4 Coconut husk (38.89 cm). The minimum plant spread was recorded in the treatment T_1 Without mulch (27.25 cm). The extended retention of moisture and availability of moisture also leading to higher uptake of nutrient for proper growth and development of plants, resulted higher growth of plant as compared to control. The changes in soil temperature below plastic mulch could be attributed to different manners of heating and heat transfer to soil and also to heat accumulation during day and loss during night. Similar findings have also been obtained by Deanban *et al.,* (2004) [11], Ansary and Roy (2005) [6] in watermelon, Al Majali and Kasrawi (1995) [4] in muskmelon and Alemayehu-Ambaye and Joseph (2002) [5] in melon. This might be due to the reason that soil under the mulch remained loose and well aerated which leads to increasing root activity thus significantly improved plant spread. Similar kind of results also obtained by Kher*et al*., (2012) [17], and Bakshi *et al.,* (2015) [7] in strawberry.

Number of runners

The perusal of data in Table 1. Clearly indicates significant effect of mulching material on number of runners per plant. The highest number of runners per plant was observed in treatment T_{11} Black polythene (12.37) which was found at par T_3 Paddy straw (12.27), and lowest number of runners per plant was noted in the treatment T_1 Without mulch (7.23) during first year. In the second-year treatment T_3 Paddy straw (13.88) again showed maximum number of runners per plant which was found at par T_{11} Black polythene (13.36), while minimum number of runners per plant was noted in the treatment T_1 Without mulch (7.72).

The mean of two year also revealed the maximum number of runners per plant in the treatment T_3 Paddy straw (13.06) which was found at par with T_{11} Black polythene (12.85). The minimum number of runners per plant was recorded in the treatment in the treatment T_1 Without mulch (7.47).

Among the different mulching treatments, black polythene mulch showed significant superiority in reducing weed population over rest of the treatments. This effect may be due to smothering effect and causing physical barrier to photosynthetic activity imparted by polythene mulches. The data presented in above can clearly indicate that plants mulched with black polythene recorded the maximum number of runners in strawberry (Ali and Gaur 2013) [3].

Days taken to first flowering

The data regarding days taken to first flowering in Effect to various mulching material presented in Table 2. States that the Minimum days taken to first flowering was noted in T_{11}Black polythene (18.73) which was also found at par with treatment T_5 Paddy husk (19.04), T_7 Cut grass (19.08) and T_3 Paddy straw (20.18), whereas Maximum days taken to first flowering was noted in T_1 Without mulch (25.00) during first year. In the second year treatment T_{11} Black polythene (17.88) again showed minimum days taken to first flowering which was also found at par with treatment T_5 Paddy husk (20.27), whereas Maximum days taken to first flowering was noted in treatment T_1 Without mulch (25.56).

The pooled data of two revealed the earliest flowering in the treatment T_{11}Black polythene (18.31) also found significantly superior over the other treatments. The late flowering was recorded in the treatment T_1 Without mulch (25.27).

With beginning of flowering, plant enters into reproductive stage. Early flowering have a significant effect on fruit setting fruit number size and qualify of the fruit in a short duration only early flowering can ensure better yield and fruit quality. Plekhanova and Pctrova (2002) [32] Ali and Gaur (2007) [3] reported that black plastic mulch accelerates flowering. It also increase percentage of fruit set and fruit number and total fruit weight is also high.

Number of fruits per plant

The data presented in Table 2 clearly depict the significant effect of mulching material on number of fruits per plant. The maximum number of fruits per plant was recorded in treatment T_{11} Black polythene (21.20) which was found at par with T_5 Paddy husk (20.50) and T_3 Paddy straw (20.34), whereas minimum number of fruits per plant was noted in the treatment T_1 Without mulch (14.73) during first year. In the second-year treatment T_{11} Black polythene (22.50) again showed highest number of fruits per plant which was found at par with T_3 Paddy straw (21.33), while lowest number of fruits per plant was noted in the treatment T_1 Without mulch 14.73).

The pooled data of two year also revealed the maximum number of fruits per plant in the treatment T_{11} Black polythene (21.83) which was found at par with T_3 Paddy straw (20.82). The minimum number of fruits per plant was recorded in the treatment T_1 Without mulch (14.73). Plants under black polythene mulch produced higher yield per growth owing to favourable hydrothermal regime of soil and complete weed free environment. Similar observation on increased yield with larger fruits, following mulching with black polythene has also been reported by Kher *et al.* (2010) [17]. Also, the grades of the experiment verified that black polyethylene mulching increased the number of fruits per plant as compared to other mulches of sugarcane trash, paddy straw, grasses, sawdust and clear polyethylene. These observations are in confirmation with the findings of Shokouhian and Asghari (2015) [40] who reported that application of black polythene mulch increased the number of fruits per plant in strawberry as compared to paddy straw and clear polyethylene mulch.

Fruit length (cm)

The data regarding fruit length in Effect to various mulching material presented in Table 2. States that The maximum fruit length was noted in T_{11} Black polythene (2.99 cm) which was also found at par with treatment T_5 Paddy husk (2.89), T_3 Paddy straw (2.70 cm), T_9 Blue polyethene (2.57 cm) and T_8 Green polyethene (2.54 cm), whereas minimum value was recorded in treatment T_1 Without mulch (2.01cm) during first year. In the second year treatment T_{11} Black polythene (3.43 cm) again showed maximum fruit length which was also

found significantly superior over the other treatments, whereas minimum value was recorded in treatment T_1 Without mulch (1.85 cm).

The pooled data of two revealed the highest fruit length in the treatment T_{11} Black polythene (3.21 cm) which was also found at par with T_3 Paddy straw (2.78 cm). The minimum fruit length was recorded in the treatment T_1 Without mulch (1.93 cm). Mulching had also significant effect on all over parameters *viz*. fruit growth, yield and quality as compared to without mulching. Mulching improved plant growth and development. Swenson *et al*. (2004) [40], miller *et al*. (2002) [25] reported that mulching was Improved the water infiltration and higher water retention. Mulching was also increase in growth characteristics also been reported by Dobbelaere (2000) [12]. Similar results have also been reported by Moor *et al*. (2004) [24]. Lamarre *et al*. (1996) [21] reported increase in fruit size and yield with mulching in cv. Tribute, sites in Canada. Similar observations in cv. Chandler have also been reported by Probosco *et al*. (1994) [34]. It appears that black polyethylene mulch might have induced favourable conditions conducive for attainment of berries with higher length. Results obtained are in accordance with the results of Pandey *et al.,* (2016) [31] in strawberry.

Fruit width (cm)

The perusal of data in Table 2 clearly indicates significant effect of mulching material on fruit width. The highest value of fruit width was observed in treatment T_{11} Black polythene (1.36 cm), whereas lowest value of fruit width was noted in the treatment T_1 Without mulch (0.95 cm) during first year. In the second-year treatment T_{11} Black polythene (1.74 cm) again showed maximum fruit width, while minimum was noted in the treatment T_1 Without mulch (0.89 cm).

The mean of two year also revealed the maximum fruit width in the treatment T_{11} Black polythene (1.53 cm) which was found at par with T_3 Paddy straw (1.35 cm). The minimum fruit width was obtained in the treatment T_1 Without mulch (0.92 cm). Mulching had also significant effect on all over parameters *viz*. fruit growth, yield and quality as compared to without mulching. Mulching improved plant growth and development. Swenson *et al*. (2004) [33], miller *et al*. (2002) [24] reported that mulching was Improved the water infiltration and higher water retention. Mulching was also increase in growth characteristics also been reported by Dobbelaere (2000) [12]. Similar results have also been reported by Moor *et al*. (2004) [24]. Lamarre *et al*. (1996) [24] reported increase in fruit size and yield with mulching in cv. Tribute, sites in Canada. Similar observations in cv. Chandler have also been reported by Probosco *et al*. (1994) [33]. The black polyethylene mulch might have induced favourable conditions conducive for attainment of berries with higher width. Results obtained are in accordance with the results of Pandey *et al.,* (2007) [30] in strawberry.

Table 1: Effect of various mulching material on Vegetative growth attributes of strawberry (*Fragaria x ananassa* Duch.) cv. Winter Dawn

Treatments	Plant height (cm)			No. of leaves			Plant spread (cm^2)			No. of runners		
	1st yr	2nd yr	Pooled	1st yr	2nd yr	Pooled	1st yr	2nd yr	Pooled	1st yr	2nd yr	Pooled
T_1-Control (Without Mulching)	7.88	8.00	7.94	11.23	10.80	11.02	27.52	26.97	27.25	7.23	7.72	7.47
T_2-Wheat straw (5 t/ha)	9.57	9.93	9.75	9.24	9.73	9.47	31.06	33.04	32.03	8.94	10.50	9.71
T_3-Paddy straw (5 t/ha)	11.29	11.27	11.28	11.66	12.30	11.97	29.32	31.19	30.24	12.27	13.88	13.06
T_4-Coconut husk (5 t/ha)	10.04	10.41	10.23	13.41	14.11	13.75	38.00	39.81	38.89	8.09	9.59	8.83
T_5-Paddy husk (5 t/ha)	13.45	13.35	13.40	16.75	17.25	16.99	37.00	35.02	36.00	11.74	11.50	11.60
T_6-Saw dust (5 t/ha)	9.43	9.78	9.61	12.92	13.59	13.24	36.73	35.47	36.08	10.10	11.23	10.65
T_7-Cut grass (5 t/ha)	9.73	10.09	9.91	11.29	11.88	11.57	29.39	34.51	31.93	8.12	11.23	9.66
T_8-Green polythene (200 gaze)	9.73	10.09	9.91	11.51	12.12	11.80	35.71	36.18	35.93	11.22	12.06	11.63
T_9-Blue polythene (200 gaze)	11.12	11.32	11.22	13.41	14.16	13.77	35.28	34.38	34.82	11.42	11.01	11.20
T_{10}-Transparent polythene (200 gaze)	10.83	11.23	11.03	9.27	9.77	9.50	31.42	34.08	32.73	9.10	11.57	10.32
T_{11}-Black polythene (200 gaze)	13.94	14.33	14.14	18.31	19.21	18.75	39.15	40.04	39.58	12.37	13.36	12.85
F- test.	S	S	S	S	S	S	S	S	S	**S**	**S**	**S**
S.Ed (±)	0.653	0.608	0.619	0.736	0.669	0.689	1.596	1.717	0.983	0.923	0.925	0.681
SE(m)	0.462	0.430	0.438	0.520	0.473	0.487	1.128	1.214	0.695	0.653	0.654	0.482
C. D. (P.= 0.05)	1.307	1.216	1.239	1.472	1.338	1.378	3.192	3.435	1.967	1.846	1.850	1.362

Table 2: Effect of various mulching material on flowering and fruiting attributes of strawberry

Treatments	Days taken to first flowering (in days)			No. of fruit per plant			Fruit length (cm)			Fruit width (cm)		
	1st yr	2nd yr	Pooled	1st yr	2nd yr	Pooled	1st yr	2nd yr	Pooled	1st yr	2nd yr	Pooled
T_1-Control (Without Mulching)	25.00	25.56	25.27	14.73	14.73	14.73	2.01	1.85	1.93	0.95	0.89	0.92
T_2-Wheat straw (5 t/ha)	24.86	22.75	23.79	16.64	17.64	17.13	2.18	2.29	2.24	1.08	1.11	1.08
T_3-Paddy straw (5 t/ha)	20.18	21.40	20.78	20.34	21.33	20.82	2.70	2.86	2.78	1.32	1.41	1.35
T_4-Coconut husk (5 t/ha)	24.67	25.86	25.25	15.70	16.72	16.20	2.04	2.24	2.14	1.02	1.13	1.06
T_5-Paddy husk (5 t/ha)	19.04	20.27	19.64	20.50	18.77	19.62	2.89	2.69	2.79	1.33	1.26	1.28
T_6-Saw dust (5 t/ha)	21.75	23.29	22.51	17.93	19.20	18.55	2.36	2.57	2.47	1.16	1.27	1.20
T_7-Cut grass (5 t/ha)	19.08	22.41	20.73	15.73	18.48	17.09	2.05	2.46	2.26	1.02	1.22	1.11
T_8-Green polythene (200 gaze)	23.26	23.50	23.37	19.18	19.37	19.26	2.54	2.59	2.57	1.24	1.28	1.25
T_9-Blue polythene (200 gaze)	23.57	22.61	23.07	19.44	18.65	19.03	2.57	2.51	2.54	1.24	1.27	1.24
T_{10}-Transparent polythene (200 gaze)	20.39	22.13	21.25	16.82	18.25	17.52	2.20	2.43	2.32	1.04	1.21	1.11
T_{11}-Black polythene (200 gaze)	18.73	17.88	18.31	21.20	22.50	21.83	2.99	3.43	3.21	1.36	1.74	1.53
F- test.	**S**	**S**	**S**	S	S	S	S	S	S	S	S	S
S.Ed (±)	1.261	1.193	0.783	0.996	1.060	0.720	0.235	0.176	0.174	0.127	0.089	0.095
SE(m)	0.891	0.844	0.554	0.704	0.750	0.509	0.166	0.125	0.123	0.090	0.063	0.067
C. D. (P.= 0.05)	2.522	2.387	1.566	1.992	2.121	1.440	0.470	0.353	0.349	0.254	0.177	0.190

Conclusion

From the present experiment it was concluded that the treatment (T_{11}) black polythene mulch had a favorable effect on the vegetative growth and flowering, fruiting attributes of strawberry cv. Winter Dawn compared to other treatments. Despite the lack of synthetic inputs, Black polythene mulch have been shown to increase strawberry plant growth, yield, and health by releasing compounds into the rhizosphere that may inhibit various diseases as biocontrol agents. This practice in production of strawberry can be forwarded to the strawberry farmers to enhance their production and productivity. Overall, this treatment can be safely and economically recommended to strawberry growers to obtain high yield per hectare.

References

1. Abdul-Baki AA, Teasdale JR. A no tillage tomato production system using hairy vetch and subterranean clover mulches. Hort Sci. 1993;28:106-108
2. Adekalu KO, Okunade DA, Osunbitan JA. Compaction and mulching effects on soil loss and runoff from two southwestern Nigeria agricultural soils. Geoderma. 2006 Dec 31;137(1-2):226-230.
3. Ali A, Gaur GS. Effect of mulching on growth, fruit yield and quality of strawberry (*Fragaria* x *ananassa* Duch.). Asian J Hort. 2007;2(11):149-151.
4. Al-Majali MA, Kasrawi MA. Plastic mulch use and method of planting influences on rainfed muskmelon production. Pure and Applied Sci. 1995;22(4):1039-1054
5. Alemayehu Ambaye, Joseph PA. Influence of drip irrigation and mulching on soil moisture retention, water use efficiency, growth and yield of oriental pickling melon (*Cucumis melo* L. var. Conomanmakino) South Indian Hort. 2002;50(4/6):421-429.
6. Ansary SH, Roy DC. Effect of irrigation and mulching on growth, yield and quality of watermelon (*Citrullus lonatus* Thumb.) Environment and Ecology. 2005;23(spl-1):141-143.
7. Bakshi P, Bhat DJ, Wali VK, Sharma A, Iqbal M. Growth, yield and quality of strawberry (*Fragaria* x *ananassa* Duch.) cv. Chandler as influenced by various mulching materials. African Journal of Agricultural Research. 2014 Feb 13;9(7):701-706.
8. Dobbelaere S, Croonenborghs A, Thys A, Ptacek D, Vanderleyden J, Dutto P, *et al*. Responses of agronomically important crops to inoculation with Azospirillum. Functional Plant Biology. 2001;28(9):871-9.
9. Dadheech S, Ramawtar, Yadav CM. Impact of Mulching Material on the Growth, Yield and Quality of Watermelon (*Citrullus lonatus*). Int. J Curr. Microbiol. App. Sci. 2018;7(07):2774-2782.
10. Das BC, Maji S, Mulieh SR. Response of soil covers on guava cv. L-49. J. Crop & Weed. 2010;6(2):10-14.
11. Dean Ban, Zanic K, Dumicic G, Culjak TG, Ban SG. The type of polythene mulch impact on vegetable growth, yield and aphid population in watermelon production. J. food Agri. and Envi. 2004;7(3-4):543-550.
12. Dobbelaere S, Croonenborghs A, Thys A, Ptacek D, Vanderleyden J, Dutto P, *et al*. Responses of agronomically important crops to inoculation with *Azospirillum*. Functional Plant Biology. 2001;28(9):871-879.
13. Fisher RA. Theory of Statistical Estimation. 1950;11:699a-11.725
14. Gaikwad SC, Ingle HV, Panchbhai DM. A note on the effect of different types of mulches on growth, yield and quality of Nagpur mandarin. Orissa J. Hort. 2004;30(1):78-81.
15. Hassan *et al*. Corollary use of mulches and pgr's on physicochemical properties of strawberry (*Fragaria* × *ananassa*) cv. Camarosa in polytunnel. Plant Archives. 2018;18(2):1745-1750.
16. Hancock JF. Strawberries. CAB International, Wallingfold, UK. 1999;237:3.
17. Kher R, Baba JA, Bakshi P, Wali VK. Effect of planting time and mulching material on quality of strawberry. J. Res. 2010;9(1):54-62.
18. Khokhar UU. Effect of different mulches and herbicide on growth, yield and quality of strawberry (*Fragaria* × *ananassa* Duch.) cv. Chandler. New India publishing Agency, New Delhi; c2006. p. 313-320
19. Kumar R, Tandon V, Mir MM. Impact of different mulching materials on growth, yield and quality of strawberry (*Fragaria* × *ananassa* Duch.). Progressive Hortic. 2012;44(2):234-236
20. Lamont WJ. The use of different colored mulches for yield and earliness. The New England Vegetable and Berry Growers Conference and Trade Show, Sturbridge, Mass; c1999. p. 299-302.
21. Lamarre M, Lareau MJ, Payette S, Fortin C. Influence of nitrogen fertilization, row covers and cultivars on the production of day-neutral strawberries in Quebec. Canad. J Soil Sci. 1996;76(1):29-36.
22. Mathad JC, Jholgiker P. Effect of synthetic and organic mulches in improving growth, yield and quality of strawberry under subtropical ecosystem. Acta Hortic, 2005;696:56-61
23. Messiaen CM. The tropical vegetables garden, Macmillan presse Ltd., London and Basingstoke in cooperation with CTA. The Netherlands, 1992, 514.
24. Moor U, Karp K, Poldma P. Effect of mulching and fertilization on the quality of strawberries. Agric. Food Sci. 2004;13:256-267.
25. Miller Chang. Hydrological properties of clay laom soil after long-term cattle manure application. J environ. 2002;31:989-996.
26. MS, Bano A, Qureshi KM. Response of strawberry (*Fragaria ananassa*) cv. Chandler to different mulching materials, Science, Technology and Development. 2016;35(3):117-122.
27. Nath JC, Sharma R. A note on the effect of organic mulches on fruit quality of Assam lemon (*Citrus limon* Burm.). Indian J Hort. 1994;23(1):46-48.
28. Nagalakshmi S, Palanisamy D, Eswaran S, Sreenarayanan VV. Influence of plastic mulching on chilli yield and economics. South Indian Horticulture. 2002;50(1/6):262-265.
29. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. ICAR Publication, New Delhi, India; c1967. p. 100-106.
30. Pandey S, Tewari GS, Singh J, Rajpurohit D, Kumar G. Efcacy of mulches on soil modifcations, growth, production and quality of strawberry (*Fragaria* × *ananassa* Duch.). I.J.S.N. 2016;7:813-820
31. Patil N. Response of strawberry (*Fragaria* × *ananassa*

Duch.) cv. Chandler to different mulches. M.Sc. Thesis, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttrakhand (India); c2011.
32. Plekhanova MN, Petrova MN. Influence of black plastic soil mulching on productivity of strawberry cultivars in northwest Russia. Ada Hurt (ISHS), 2002;567:491-494
33. Probasco PR, Garrison SA, Fiola JA. Annual strawberry production on plastic mulch. In: 25th National Agricultural Plastics Congress. Proc. Conf. held in Lexington, k Y., USA, @#-27 September, 1994(ed. By Jones, T.T.) St. Augustine, USA, Am. Soc. For Plasticulture; c1994. p. 215-220.
34. Rana, Chandel. Effect of biofertilizers and nitrogen on growth, yield and fruit quality of strawberry. Progressive Horticulture. 2003;35(1):25-30
35. Sharma RM, Khajuria AK, Kher R. Evaluation of Some Strawberry (*Fragaria* x *ananassa* Duch) Cultivars under Jammu Plains. Indian Journal of Plant Genetic Resources. 2002;15(2):192-194. Print ISSN: 0971-8184
36. Shokouhian AA, Asghari A. Study the effect of mulch on yield of some strawberry cultivars in Ardabil condition. Int. Conference on Agric, Eco. and Bio Engineering; c2015.
37. Singh AK, Singh S, Rao VV, Bagle BG, More TA. Efficacy of organic mulches on soil properties, earthworm population, growth and yield of aonla cv. NA7 in semi-arid ecosystem. Indian Journal of Horticulture. 2010;67(4):124-128.
38. Soliman MA, El-Aal A, Hala A, Mohmed R, Elhefnawy NN. Growth, fruit yield and quality of three strawberry cultivars as affected by mulch type and low tunnel. Alexandria Science Exchange Journal. 2015 Dec 30;36(October-December):402-14.
39. Swenson JA, Walters SA, Chong SK. Influence of tillage and mulching systems on soil water and tomato fruit yield and quality. Journal of vegetable crop production. 2004 Oct 4;10(1):81-95.
40. Shokouhian AA, Asghari A. Study the effect of mulch on yield of some strawberry cultivars in Ardabil condition. Int. Conference on Agric, Eco. and Bio Engineering; c2015.
41. Thakur M, Shylla B. Influence of different growing media on plant growth and fruit yield of strawberry (*Fragaria* × *ananassa* Duch.) cv. Chandler grown under protected conditions. Int. J Curr. Microbiol. Appl. Sci. 2018;7(4):2724-30.
42. Verma ML, Bhardwaj SP, Thakur BC, Bhandari AR. Nutritional and mulching studies in apple. Indian Journal of Horticulture. 2005;62(4):332-335.