**Effect of different mulching material and micronutrients on growth and quality of strawberry (*Fragaria* x *ananassa* Duch) cv. Winter Dawn**

**Abstract**

The study used Randomized Block Design, which is a type of experimental design that helps investigate the effects of few factors simultaneously. The treatments comprising different mulches and fertigation *viz.* three types of mulching (black polythene, white polythene and 5 cm thick rice husk mulch) and three types of micronutrients *viz.* (0.4 % ZnSO4, 0.4 % FeSO4, and 0.2% Boron) and control. Among the various types of mulching and different types of micronutrients spray, maximum plant height, plant spread, plant weight (fresh and dry),fruit length, fruit width, fresh and dry fruit weight, maximum TSS, TSS/acid ratio, total sugar, reducing sugar, non-reducing sugar, ascorbic acid content, juice content and anthocyanin content was recorded under the treatment Black polythene +0.2 % Boron. This aligns with the well-established understanding that both mulches and fertigation are critical factors in regulating the growth and quality parameters of strawberry.

**Keywords: *Strawberry, Micronutrients, Mulching, Economic***

**Introduction**

Strawberry (*Fragaria* x *ananassa* Duch) is a cross between two American species *Fragaria × chiloensis* Duch and *Fragaria × virginiana* Duch which belongs to the family Rosaceae. Its cultivated varieties is octaploid (2n=56) in nature. It occupies a considerable position in fruit crops since it is cultivated in plains and also up to the elevation of 3000 MSL in humid or dry areas of the world. Botanically, strawberry fruits are known as Eterio of achenes and means have numerous small achenes present on periphery of the fruit. Achenes are monocarpous and indehiscent seeds (doesn’t split open) that are present on the surface of fruit, which helps in escalation of berries. Strawberry is an aggregate fruit type (developing from single flower with many ovaries) and highly perishable because of delicateness Kachwaya and Chandel (2015). It is herbaceous plant, which behaves as an annual in the sub-tropical and perennial in temperate region. Strawberry has refreshing, delicious, attractive, nutritive, tremendous aroma and tantalizing flavour (Kher *et al.,*2010). Fruit contains 98 per cent edible portion and are widely accepted due to pleasant flavour, conspicuous color and varied blendof taste. The delicacy of taste, richness in mineral nourishment makes berries a food in the diet of millions of populace around the world (Kumar *et al* (2012); and have low calorific value and fatty acids;also possesses higher P, K, Ca and Fe contents (Kumar and Dey 2011). Vitamin B, C and proteins also makes strawberry good for health. Strawberry is mostly utilized for table purposes and various value supplementary products like jam, canning, ice- cream preparations, RTS beverages, wine; soft drinks etc are prepared from its fruit.

Mulching is application of mulched (covered) soil with loose extraneous organic and inorganic materials. It reduces evaporation and moderates widely an increase and decrease in diurnal soil temperature especially near the root zone. Though, it restricts solar radiation falling on the ground but being an insulating agent, mulched soils are warmer in winter and cooler in summer. It also inhibits weed population and represses weed competition with the main crop for nutrients and water uptake as the result; these get more available to crop plants (Mahadeen, 2014). Moreover, the practice of mulching enhanced infiltration of water and its percolation deeper in the soil profiles. It also reduces water losses due to fall in thermal gradients and exchange of vapours. Investigation on the influence of various type of mulches material on vegetative growth, yield and quality attributes depicted in the literature that strawberry plant is more responsive to the different mulch materials. Mulches directly influence duration of harvesting, organoleptic and other production parameters and which primarily depend upon soil moisture conservation, soil temperature, nutrient accessibility, inhibition of weeds and shelter from frost injury and check the soiled and contaminated berries (Taparauskiene and Miseckaite, 2014). Strawberry is a surface feeder plant, thus requires more frequent irrigations to maintain optimum soil moisture. Optimum vegetative growth of strawberry has been obtained under soil moisture conditions where tension does not exceed 1.0 atm. In general, strawberries are irrigated with furrow method but now a day’s drip irrigation has gained popularity because of maximum water use efficiency.

“Among various micro-nutrients, iron (Fe) and zinc (Zn) plays an important role in promoting vegetative growth, flowering, yield and quality of strawberry fruits” (Chaturvedi *et al*.*,* 2005). Iron (Fe) is one of the essential elements required by the plants owing to its vital and essential role on plant growth and development. It also participate in number of plant biochemical processes such as biosynthesis of cytochrome and chlorophyll besides being component of various enzymes *viz* flavor protein, peroxidases and catalase, though iron is not a constituent of chlorophyll yet it acts as a catalyst for synthesis and maintenance of chlorophyll.

“It is also a constituent of enzyme systems and so it plays an important role in plant enzyme reactions” (Das, 2006). “Zinc also plays an important role in photosynthesis and related enzymes resulting in increasing sugar and decreasing acidity” (Abedy, 2001). Mahnaz *et al*., 2010 claimed that “ZnSO4 as a source of zinc had a positive effect in increasing leaf area, length and diameter of petiole, fresh and dry shoot ratio, yield, TSS, acidity and Vitamin-C of strawberry plant”.

**Materials and Methods**

***Location***

Kota district is located at 25.18° N to 75.83° E Latitude in South Eastern Rajasthan. It covers an area of 221.36 km2. Agro-climatically, the district falls in Zone V, known as Humid South Eastern Plain. The average rainfall in the region is 660.6. mm. Maximum temperature range in the summer is 40 to 48°C and minimum 1.0- 2.6°C during winter (Table 3).

***Plant Material***

We acquired the strawberry plants cv. Winter Dawn from K.F. Bioplants, located in Pune (Maharashtra), and were pleased to find them in excellent health and uniformity in terms of growth and vigor. The Winter Dawn variety is most suitable variety in that region. To ensure the accuracy of our assessment on the effects of various treatments, we maintained uniform cultural practices across all experimental plots. This included the application of fertilizers and plant protection measures as needed. Raised beds were prepared for planting, and white mulch materials used under open field conditions in all treatments. The experiment was carried out according to proposed plan.

***Experimental Details***

The present experiment was conducted at the Department of Horticulture, School of Agricultural Sciences, Career Point University, Kota (Rajasthan) during the year 2023-24. The experiment involved using a raised bed planting system with spacing of 60 x 30 cm to grow a specific crop. The experimental design used for the study was Randomized Block Design with three replications, in open field condition which helps in reducing bias and obtaining reliable results by randomly assigning treatments to different blocks. The experiment consisted of sixteen treatments comprising different mulching and micronutrients *viz.* No mulch+0% micronutrients (T0), No mulch+0.4 % ZnSO4, (T1), No mulch+0.4 % FeSO4 (T2), No mulch+0.2 % Boron (T3), Black polythene +0% micronutrients (T4), Black polythene +0.4 % ZnSO4 (T5), Black polythene +0.4 % FeSO4 (T6), Black polythene +0.2 % Boron (T7), White polythene+0% micronutrients (T8), White polythene+0.4 % ZnSO4 (T9), White polythene+0.4 % FeSO4 (T10), White polythene+0.2 % Boron (T11), Rice husk+0% micronutrients (T12), Rice husk+0.4 % ZnSO4 (T13), Rice husk+0.4 % FeSO4 (T14), Rice husk+0.2 % Boron (T15).

## Preparation of solution and foliar application of micro- nutrients

For preparation of micro-nutrients solution the desired amounts of micro- nutrients were thoroughly dissolved in required amount of water and surfactant was added as a spreader and sticker. The solutions of different concentrations were spread carefully to wet both the surfaces of the whole plant. Care was taken to have a uniform spray of the plant. The solution, which fell from the leaves, was collected on polythene sheets, which were spread on the ground. The precaution was taken to avoid the addition of nutrients to the soil. Spraying of micro-nutrients was done with the help of knap sack sprayer and to avoid contamination sprayer was washed thoroughly before spraying.

## Time of spray

The desired concentrations of micro-nutrients were prepared and sprayed at 30 and 60 days after the planting of strawberry plants.

***Measurement of the morphological parameters***

The plant height was taken from the tagged plant in each replication (Three) after completion of harvesting period with the help of a meter scale, total number of leaves were counted from tagged plants in every replication behind completion of harvesting time and expressed as standard number of leaves per plant the spread of the tagged plants was recorded in east-west and north-south direction individually with the help of a meter scale and the average of five plants for all direction was calculated, fresh and dry weight of the plants was measured after completion of harvesting, tagged plants were uprooted and cleaned properly. They were then dried in oven at 70° C and the weight was recorded.

***Determination of the quality parameters***

Fruit length and widthwas recorded of 10 fruits from every treatment by the help of digital vernier caliper. The fruits weight from every tagged plant was taken on each date of harvest by the help of electronic weight balance and the mean was articulated as weight of fruit in gram. The dry weight of the strawberry fruit was observed by drying the fruits in oven at 70°C temperature till the invariable weight up to 2 days. The value was averaged to record the data. The acidity and vitamin c of the fruit juice was measured the method given by A.O.A.C. TSS: acid ratio was estimate mathematically by dividing the value of TSS with titrable acidity and the data so obtained was expressed as TSS: acid ratio, sugars content was measured by the fehling’s solution method given by A.O.A.C. (2013), juice was weighed with the help of balance and the percentage of juice was worked out on the basis of total weight of fruit and weight of juice, for anthocyanin weighing 5.0 g of the homogenized strawberry fruits samples were dissolved in 25 ml methanolic hydrochloric acid (85:15) solution and samples were kept for one day at cool temperature (4-5 0C) for the taking out of anthocyanin. The flocculate was filtered off by a Whatman filter paper No. 1 and the absorbance of the resulting apparent liquid was measured at 535 nm in Spectrophotometer (Aaby *et al.,* 2005).

**Results**

***Morphological parameters***

The data recorded regarding the effect of different mulch materials and fertigation levels on plant height of strawberry are presented in Table 1. The treatment M1T3: Black polythene + 0.2 % Boron recorded the maximum plant height (43.95 cm), whereas, the minimum plant height (11.57 cm) was recorded in treatment (M0T0): No mulch+ 0% Micronutrients. Treatments M1T2 was found at par from each other. All other treatments were found significantly different from each other. Irrespective of the mulch materials and micronutrients recorded significantly higher number of leaves per plant in strawberry (Table 1). The maximum number of leaves per plant (97.88) was recorded in treatment M1T3: Black polythene + 0.2 % Boron. In contrast, lower number of leaves (18.77) was recorded in the treatment M0T0: No mulch+ 0% Micronutrients. Treatments, M1T2 was noted at par with each other.

Data pertaining to plant spread (E-W and N-S) of strawberry plants grown with use of mulches and different micronutrient levels. Table 1 reveal that in both E-W and N-S directions The maximum E-W spread (51.47 cm) and N-S (49.55 cm) spread was recorded in plants grown with the treatment M1T3: Black polythene + 0.2 % Boron, whereas, minimum E-W spread (21.91 cm) and N-S spread (19.88 cm) was observed in treatment M0T0: No mulch+ 0% Micronutrients. Treatments M1T2, was observed at par with each other in respect to E-W and N-S spread.

Observations recorded for plant weight (fresh and dry weight) of strawberry as a result of mulching and micronutrient levels are presented in Table 1. Strawberry plants in treatment M1T3: Black polythene + 0.2 % Boron recorded maximum fresh weight (235.81g) and dry weight (57.85 g) in comparison to all other treatment combinations. Plants grown in treatment M0T0: No mulch+ 0% Micronutrients had significantly minimum plant fresh weight (18.99g) and minimum plant dry weight (8.44g).

***Physical quality parameters***

There was significant difference among various treatment combinations with respect to their effect on fruit length of strawberry (Table 2). The fruit length in plants grown in treatment M1T3: Black polythene + 0.2 % Boron was maximum (55.63 mm) than those obtained in this study. However, the minimum (28.63 mm) length of fruit was recorded in treatment M0T: No mulch+ 0% Micronutrients. However, Fruits produced in the treatment M1T3: Black polythene + 0.2 % Boron had the maximum fruit width (43.73 mm). Fruits grown in the treatment M0T0: No mulch+ 0% Micronutrients recorded the minimum fruit width (21.54 mm). The fresh weight and dry weight of strawberry fruits grown with different mulching materials in different growing micronutrients are given in Table 2. Fruits in the treatment M1T3: Black polythene + 0.2 % Boron recorded the maximum fresh weight (31.71 g) and dry weight (3.58 g) as compared to other treatments. Treatment M0T0: No mulch+ 0% Micronutrients recorded minimum fresh weight (10.25 g) and dry weight (1.21 g) among all the treatments respectively.

***Chemical quality parameters***

Table 3 depicts the total soluble solids of strawberry fruits grown with different mulches and micronutrients. The TSS of strawberry fruits ranged from 5.84- 7.28° B. There was significant difference among various treatment combinations for their effect on TSS. However, strawberry plants grown using treatment M1T3: Black polythene + 0.2 % Boron had fruits with the maximum TSS (7.28°B) while the minimum (5.84°B) was recorded in treatment M0T0: No mulch+ 0% Micronutrients. No significant difference was recorded among various treatment combinations in their effect on titratable acidity of the fruits (Table 3). The titratable acidity of strawberry fruits ranged from 1.43 to 1.92 per cent with no difference between them. The maximum (1.92 per cent) mean titratable acidity was recorded in fruits grown in treatment M0T0: No mulch+ 0% Micronutrients, while, the minimum (1.43 per cent) was found in fruits grown in treatment M1T3: Black polythene+0.2 % Boron.

Table 3 depicts the TSS/acid ratio of strawberry fruits grown with different mulches and fertigation. Maximum TSS/acid ratio (5.09) was observed in treatment M1T3: Black polythene+0.2 % Boron. The minimum TSS/acid ratio (3.04) was recorded in treatment M0T0: No mulch+ 0% Micronutrients. Rest all treatments were found significantly different from each other.

Although no significant differences were found among various treatment combinations for their effect on total sugars, there was variability among treatments for total sugars content (Table 3). A perusal of the data reveals that maximum total sugar content (5.15%) was recorded in fruits grown in treatment M1T3: Black polythene+100% fertigation, whereas the minimum total sugars content (2.10%) was found in fruits grown in the treatment M0T0: No mulch+ 0% Micronutrients. Similarly, maximum reducing sugar (4.08%) in fruits produced in treatment M1T3: Black polythene+0.2 % Boron, while minimum (1.53%) in treatment combination M0T0: No mulch+ 0% Micronutrients.

Table 4 depicts the data regarding the non-reducing sugar recorded in the strawberry fruits. They reveal maximum non-reducing sugar (1.09%) in fruits produced in treatment M1T3: Black polythene+0.2 % Boron, while minimum (0.57%) in treatment combination M0T0: No mulch+ 0% Micronutrients.

The data pertaining to the effect of mulch material and micronutrients on vitamin C content of strawberry are presented in Table 4. The vitamin C content of fruits ranged from 36.49 mg100g-1to 52.21 mg100g-1. The maximum vitamin C (52.21 mg100g-1) was recorded in treatment M1T3: Black polythene + 0.2 % Boron while minimum (36.49 mg100g-1) was recorded in treatment M0T0: No mulch+ 0% Micronutrients.

The data recorded as regard to the effect of different mulch materials and micronutrients levels on juice percentage of strawberry fruits are given in Table 4. There was significant differences among the treatment combinations for their effect on juice percentage of strawberry fruits which ranged between 60.27 to 96.05 per cent. The maximum juice percentage (96.05) per cent was observed in fruits which were grown in the treatment M1T3: Black polythene+0.2 % Boron, while, the minimum juice percentage (60.27 per cent) was recorded in treatment M0T0: No mulch+ 0% Micronutrients. Treatments M2T0, M3T1, M0T3 and M3T2 were observed at par with each other.

However, the maximum total anthocyanin content (44.44 mg 100 g-1) was recorded in plants grown in treatment M1T3: Black polythene + 0.2 % Boron and the minimum total anthocyanin content (24.41 mg 100 g-1) was recorded in treatment M0T0: No mulch+ 0% Micronutrients. Treatments M2T3, M1T1, M0T2 and M3T0 were at par for anthocyanin content of fruit.

**Discussion**

It is evident from the results obtained, that the application of plant growth regulator treatments at different concentration significantly influenced various vegetative growth as compared to control. Among the various treatments M1T3 (Black polythene +0.2% micronutrients) increased all vegetative growth related parameters such as plant height, plant spread, number of leaves, plant weight and runner production.

Katiyar *et al.,* (2009) studied the effect of mulching on plant growth in strawberry under Kanpur agro-climatic conditions and recorded maximum crown height and crown spread in the plants mulched with black polythene sheets followed by white polythene and paddy straw. Increase in vegetative growth related parameters under mulching could be due to better soil moisture retention capacity of the soil. Similar results were also reported by Hassan *et al* (2000) that mulching improved vegetative growth in Oso Grande strawberry. Similerly, In “Vilnus” Region of Lithuania, Kesik and Maskalaniec (2003) reported that “Senga Sengana” strawberries mulched with black plastic foil had more number of leaves than mulched with rye straw and wood bark. The increase in plant height of strawberry is might be due to the fact Zn +B +Fe promotes vegetative growth by active cell division and elongation and therefore the height must have increased. Another probable reason for the increase in plant height might be due to the osmotic uptake of water and nutrients under the influence of boron. These results were in close agreement with the findings of Chaturvedi *et al.* (2005), Bakshi *et al.* (2013a) Bakshi *et al.* (2013b) and Singh *et al*. (2015) in strawberry. The increase in number of leaves per plant as results of Boron application might be due to fact that activity of micronutrients at shoot meristem resulting is more system of nucleoprotein responsible for increasing leaf initiation and expansion. Similar observations on number of leaves per plant due to micronutrients were also reported by Chaturvedi *et al.* (2005), Bakshi *et al.* (2013, a) Bakshi *et al.* (2013, b) and Singh *et al*. (2015) in strawberry. Maximum fresh and dry weight of the plant in treatment M1T3 may be explained in the light of better growth of the plant under its influence.

Data pertaining to fruit length (mm), fruit width (mm), length:diameter ratio, fresh fruit weight (g) and dry weight of fruit (g) was maximum in treatment M1T3: Black polythene+0.2% micronutrients than any other obtained in this study while the minimum was recorded in treatment M0T0. Maximum fruit length (mm), fruit width (mm), length:diameter ratio, fresh fruit weight (g) and dry weight of fruit (g) was found under treatment M1T3 may be due to more favourable modification of soil temperature. This might be due to the effect of Zn, B and Fe as micronutrients plays a vital role to promote starch formation and activity involved in transportation of carbohydrates in plants. Faster loading and mobilization of photo assimilates to fruits and involvement in cell division and cell expansion, ultimately reflected into more length of fruits in treated plants. Similar results were also obtained by Bakshi *et al.* (2013,a) Bakshi *et al.* (2013,b) and Mehraj *et al*. (2015) in strawberry.

The maximum TSS was observed in M1T3 The minimum TSS (6.00°B) was recorded inM0T0. The increase in total soluble solids may be accounted to the hydrolysis of polysaccharides, conversion of organic acid in to soluble sugars and enhanced solubilization of insoluble starch and pectin present in cell wall and middle lamella. In conformity of this similar observations were reported by Kumar *et al*. (2010), Bakshi *et al.* (2013, a) Bakshi *et al.* (2013, b) and Chaturvedi *et al.* (2005) in strawberry and Singh and Chhonkar (1983) and Singh and Brahmachari (1999) in guava and Patel *et al.* (2010) and Pathak *et al.* (2011) in banana. The titratable acidity was observed in  
non-significant. Maximum TSS/acid ratio) was observed in treatment M1T3. The minimum TSS/acid ratio was recorded in M0T0. However, TSS, titratable acidity and TSS/acid ratio are non-significantly different from each other.

The maximum total, reducing and non-reducing sugars and vitamin C was recorded in fruits grown in treatment M1T3. The minimum total sugars content was found in fruits grown in the treatment M0T0. The increase in total sugar may be accounted to the hydrolysis of polysaccharides, conversion of organic acid in to soluble sugars and enhanced solubilization of insoluble starch and pectin present in cell wall and middle lamella which is influenced by B spray. In conformity of this similar observations were reported by Kumar *et al*. (2010), Bakshi *et al.* (2013,b) and Kazemi (2010) in strawberry and Singh and Chhonkar (1983) and Singh and Brahmachari (1999) in guava and Patel *et al.* (2010) and Pathak *et al.* (2011) in banana, Shrivastava (1969) and Shrivastava (1970) in pineapple and Rai *et al.* (1988) in other fruits crops.

Maximum juice and anthocyanin content was observed in the treatment M1T3 while minimum was recorded in M0T0. Anthocyanin accumulation in the ripening fruits depends on phenylalanine ammonia lyase (PAL) and UDPGFT (Uridine diphosphate glucose: flavonoid 3-o transferase) regulatory enzyme activities. In Nagpur mandarin, Shrigure *et al* (2001) observed that fruit juice content was highest in plant fertigated with 500:140:70 g N: P: K/tree through drip system.

**Conclusion**

Treatment M1T3: Black polythene+0.2% boron recorded the maximum plant height, number of leaves, plant E-W spread and N-S spread and plant weight- fresh weight as well as dry weight maximum fruit fresh weight as well as dry weight, fruit length, fruit width, maximum TSS, decrease in titratable acidity, TSS/acid ratio, sugars per cent, maximum juice content, Vit. C content and anthocyanin content. So that the treatment M1T3: M1T3: Black polythene+0.2% boron was found the better harvest of the crop.

**Disclaimer (Artificial intelligence)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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##### **Chart 1 Mean weekly meteorological observations during crop period (Rabi, 2023-24).**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Standard Week No.** | **Date** | **Temperature (°C)** | | **RH (%)** | | **Wind**  **velocity**  **(km hr-1)** | **Sunshine**  **(hrs)** | **Rainfall**  **(mm)** | **Evaporation (mm day-1)** |
| **Max.** | **Mini.** | **Max.** | **Mini.** |
| 43 | 22 Oct – 28 Oct | 34.5 | 17.2 | 92 | 92 | 8.8 | 8.8 | 0 | 3.11 |
| 44 | 29 Oct – 04 Nov | 34.5 | 17.2 | 92 | 92 | 9.0 | 9.0 | 0 | 2.53 |
| 45 | 05 Nov – 11 Nov | 34.8 | 18.0 | 92 | 92 | 9.4 | 9.4 | 0 | 2.68 |
| 46 | 12 Nov – 18 Nov | 31.6 | 13.1 | 92 | 92 | 9.3 | 9.3 | 0 | 3.91 |
| 47 | 19 Nov – 25 Nov | 28.9 | 12.3 | 40 | 57 | 9.5 | 9.5 | 0 | 3.41 |
| 48 | 26 Nov – 02 Dec | 28.6 | 9.2 | 43 | 62 | 10 | 10 | 0 | 3.29 |
| 49 | 03 Dec – 09 Dec | 26.8 | 8.2 | 45 | 60 | 9.4 | 9.4 | 0 | 2.57 |
| 50 | 10 Dec – 16 Dec | 27.3 | 11.3 | 38 | 64 | 9.6 | 9.6 | 0 | 2.51 |
| 51 | 17 Dec – 23 Dec | 26.9 | 10.5 | 40 | 59 | 9.2 | 9.2 | 0 | 2.39 |
| 52 | 24 Dec – 31 Dec | 24 | 10.3 | 42 | 66 | 9.80 | 9.80 | 0 | 2.06 |
| 53 | 22 Oct – 28 Oct | 34.5 | 17.2 | 92 | 92 | 8.8 | 8.8 | 0 | 3.11 |
| 1 | 01 Jan – 07 Jan | 28.9 | 12.3 | 40 | 57 | 9.5 | 9.5 | 0 | 3.41 |
| 2 | 08 Jan – 14 Jan | 28.6 | 9.2 | 43 | 62 | 10 | 10 | 0 | 3.29 |
| 3 | 15 Jan – 21 Jan | 26.8 | 8.2 | 45 | 60 | 9.4 | 9.4 | 0 | 2.57 |
| 4 | 22 Jan – 28 Jan | 27.3 | 11.3 | 38 | 64 | 9.6 | 9.6 | 0 | 2.51 |
| 5 | 29 Jan – 04 Feb | 26.9 | 10.5 | 40 | 59 | 9.2 | 9.2 | 0 | 2.39 |
| 6 | 05 Feb – 11 Feb | 24 | 10.3 | 42 | 66 | 9.80 | 9.80 | 0 | 2.06 |
| 7 | 12 Feb – 18 Feb | 34.5 | 17.2 | 92 | 92 | 8.8 | 8.8 | 0 | 3.11 |
| 8 | 19 Feb – 25 Feb | 28.9 | 12.3 | 40 | 57 | 9.5 | 9.5 | 0 | 3.41 |
| 9 | 26 Feb – 04 Mar | 28.6 | 9.2 | 43 | 62 | 10 | 10 | 0 | 3.29 |
| 10 | 05 Mar – 11 Mar | 26.8 | 8.2 | 45 | 60 | 9.4 | 9.4 | 0 | 2.57 |
| 11 | 12 Mar – 18 Mar | 27.3 | 11.3 | 38 | 64 | 9.6 | 9.6 | 0 | 2.51 |
| 12 | 19 Mar – 25 Mar | 26.9 | 10.5 | 40 | 59 | 9.2 | 9.2 | 0 | 2.39 |

**Source- ARS, Ummedganj, CoA, Agriculture University, Kota- Rajasthan**

**Table 1: Effect of mulches and micronutrients on different morphological characteristics of strawberry (*Fragaria× ananassa* Duch.) cv. Winter Dawn**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Treatments** | **Plant height (cm)** | **Plant Spread** | | **No. of leaves per plant** | **Plant Weight (g)** | |
| **Fresh weight** | **Dry weight** |
| **East-West** | **North-South** |
| M0T0 | 11.57 | 21.91 | 19.88 | 18.77 | 18.99 | 8.44 |
| M0T1 | 13.54 | 25.72 | 24.61 | 20.99 | 21.81 | 11.11 |
| M0T2 | 14.19 | 26.21 | 26.39 | 29.66 | 26.68 | 13.02 |
| M0T3 | 15.54 | 28.45 | 26.61 | 33.55 | 31.24 | 16.11 |
| M1T0 | 25.01 | 47.72 | 45.28 | 78.77 | 186.14 | 44.16 |
| M1T1 | 29.02 | 49.17 | 47.28 | 82.88 | 126.72 | 46.32 |
| M1T2 | 35.27 | 49.99 | 48.11 | 94.55 | 187.88 | 55.71 |
| M1T3 | 43.95 | 51.47 | 49.55 | 97.88 | 235.81 | 57.85 |
| M2T0 | 21.93 | 42.17 | 41.06 | 72.99 | 115.90 | 29.42 |
| M2T1 | 21.97 | 43.28 | 42.33 | 73.78 | 121.78 | 34.44 |
| M2T2 | 22.47 | 44.55 | 43.06 | 75.99 | 126.72 | 37.81 |
| M2T3 | 24.25 | 45.14 | 43.73 | 76.77 | 155.91 | 41.18 |
| M3T0 | 18.54 | 30.11 | 29.5 | 45.65 | 65.88 | 18.14 |
| M3T1 | 19.64 | 38.83 | 38.22 | 55.45 | 94.79 | 24.04 |
| M3T2 | 19.80 | 39.72 | 39.05 | 68.88 | 98.23 | 24.90 |
| M3T3 | 16.58 | 41.01 | 39.66 | 18.77 | 106.23 | 27.61 |
| **CD at 5%** | 6.45 | 9.21 | 10.23 | 16.47 | 11.60 | 15.25 |
| **SEm±** | 2.20 | 3.08 | 4.89 | 5.21 | 4.21 | 5.14 |

**Table 2: Effect of mulches and micronutrients on physical quality of strawberry (*Fragaria x ananassa* Duch.) cv. Winter Dawn**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | **Fruit**  **length (mm)** | **Fruit**  **width(mm)** | **Fruit Weight (g)** | |
| **Fresh weight** | **Dry weight** |
|
| M0T0 | 28.63 | 21.54 | 10.25 | 1.21 |
| M0T1 | 29.00 | 24.30 | 11.32 | 1.28 |
| M0T2 | 29.52 | 25.45 | 12.03 | 1.39 |
| M0T3 | 29.97 | 27.39 | 12.24 | 1.42 |
| M1T0 | 45.60 | 38.78 | 27.55 | 1.82 |
| M1T1 | 49.09 | 39.64 | 28.88 | 2.84 |
| M1T2 | 49.32 | 41.80 | 30.84 | 2.87 |
| M1T3 | 55.63 | 43.73 | 31.71 | 3.58 |
| M2T0 | 35.58 | 31.58 | 19.24 | 1.61 |
| M2T1 | 39.43 | 31.50 | 20.94 | 1.65 |
| M2T2 | 40.27 | 32.93 | 24.28 | 1.79 |
| M2T3 | 42.07 | 33.30 | 24.94 | 1.81 |
| M3T0 | 30.50 | 28.56 | 12.34 | 1.46 |
| M3T1 | 30.87 | 29.55 | 13.88 | 1.47 |
| M3T2 | 32.79 | 29.95 | 16.01 | 1.52 |
| M3T3 | 33.77 | 30.72 | 17.55 | 1.60 |
| **CD at 5%** | 6.34 | 7.20 | 12.54 | 15.47 |
| **SEm±** | 2.11 | 2.47 | 4.22 | 5.16 |

**Table 3: Effect of mulches and micronutrients on chemical quality of strawberry (*Fragaria x ananassa* Duch.) cv. Winter Dawn**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatments** | **TSS (°B)** | **Tit. Acidity (%)** | **TSS/ acid ratio** | **Total sugars (%)** | **Reducing sugars (%)** |
| M0T0 | 5.84 | 1.92 | 3.04 | 2.10 | 1.53 |
| M0T1 | 5.96 | 1.88 | 3.17 | 2.28 | 1.66 |
| M0T2 | 6.06 | 1.86 | 3.26 | 2.76 | 1.98 |
| M0T3 | 6.14 | 1.81 | 3.39 | 2.88 | 2.04 |
| M1T0 | 6.86 | 1.62 | 4.24 | 3.75 | 2.76 |
| M1T1 | 6.90 | 1.49 | 4.63 | 4.01 | 3.03 |
| M1T2 | 7.16 | 1.45 | 4.94 | 4.69 | 3.60 |
| M1T3 | 7.28 | 1.43 | 5.09 | 5.15 | 4.08 |
| M2T0 | 6.44 | 1.69 | 3.81 | 3.28 | 2.38 |
| M2T1 | 6.46 | 1.67 | 3.87 | 3.30 | 2.43 |
| M2T2 | 6.60 | 1.67 | 3.95 | 3.51 | 2.54 |
| M2T3 | 6.84 | 1.64 | 4.17 | 3.62 | 2.66 |
| M3T0 | 6.16 | 1.78 | 3.46 | 2.98 | 2.15 |
| M3T1 | 6.26 | 1.77 | 3.54 | 3.11 | 2.27 |
| M3T2 | 6.36 | 1.71 | 3.72 | 3.13 | 2.29 |
| M3T3 | 6.40 | 1.69 | 3.79 | 2.10 | 1.53 |
| **CD at 5%** | 0.16 | NS | 0.30 | 0.45 | 0.39 |
| **SEm±** | 0.58 | 0.30 | 0.11 | 0.16 | 0.13 |

**Table 4: Effect of mulches and micronutrients on chemical quality of strawberry (*Fragaria x ananassa* Duch.) cv. Winter Dawn**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | **Non reducing sugars (%)** | **Vitamin C (mg/100g)** | **Juice (%)** | **Anthocyanin content (mg/100g)** |
| M0T0 | 0.57 | 36.49 | 24.41 | 60.27 |
| M0T1 | 0.62 | 39.55 | 28.68 | 64.99 |
| M0T2 | 0.78 | 39.91 | 29.08 | 68.39 |
| M0T3 | 0.84 | 40.04 | 29.13 | 75.47 |
| M1T0 | 0.99 | 48.32 | 38.92 | 90.3 |
| M1T1 | 0.98 | 48.50 | 39.11 | 90.98 |
| M1T2 | 1.07 | 48.89 | 39.73 | 94.75 |
| M1T3 | 1.09 | 52.21 | 44.44 | 96.05 |
| M2T0 | 0.90 | 44.88 | 34.62 | 86.73 |
| M2T1 | 0.87 | 44.93 | 34.90 | 87.74 |
| M2T2 | 0.97 | 47.50 | 37.43 | 87.93 |
| M2T3 | 0.96 | 47.80 | 37.83 | 88.45 |
| M3T0 | 0.83 | 42.60 | 30.4 | 79.39 |
| M3T1 | 0.84 | 42.66 | 30.45 | 80.65 |
| M3T2 | 0.84 | 43.23 | 30.67 | 82.29 |
| M3T3 | 0.57 | 44.08 | 34.46 | 83.45 |
| **CD at 5%** | 0.6 | 8.32 | 6.80 | 8.60 |
| **SEm±** | 0.02 | 3.04 | 2.28 | 3.02 |