AATCC Review

04 February 2023: Received
06 June 2023: Revised
11 August 2023: Accepted
14 October 2023: Available Online

www.aatcc.peerjournals.net

Research Article

Open Access

Varietal Evaluation and Assessment of Plastic Mulches for Growth, Yield and Fruit Quality of Tomato (*Solanum lycopersicum* L.) Under Protected Environment

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ABSTRACT

Different genotypes and mulches are readily available in the market but Indian farmers are unaware about the performance of these genotypes and mulches in a particular region under protected environment. Therefore, considering the foregoing circumstances, the experiment was performed at Vegetable Research Farm, Department of Vegetable Science, Khalsa College, Amritsar in the spring-summer season 2022-2023 in Factorial Randomized Block Design comprising of 15 treatment combinations having five levels of mulches i.e. double shaded plastic mulch (M_1), black plastic mulch (M_2), red plastic mulch (M_3), yellow plastic mulch (M_4) and no mulch (M_5) and three genotypes i.e. EZ-9003 (G_1), NS-4266 (G_2) and check PTH-1 (G_3). The objective of the research was to study the effect of different plastic mulches on the growth, yield, and quality of tomato genotypes and to identify the most promising genotype(s) under the protected environment. The outcomes revealed that double-shaded plastic mulch surpassed other mulches for all the growth and yield-related parameters except days to first picking. Based on mean performance, significant variations have been observed in all the genotypes for various attributes which convey that PTH-1 (check) and NS-4266 are the best genotypes for growth, yield and its related traits taken under study. Biochemical analysis discovered that red and black plastic mulches surpass other treatments, whereas NS-4266 performed well for pericarp thickness and lycopene content, while check PTH-1 and EZ-9003 were best for processing purpose. The two-way interaction of Mulch (M) × Genotypes (G) was found non-significant for all the parameters omitting ascorbic acid content. The maximum net returns and B: C ratio were obtained in genotype NS-4266 and double-shaded plastic mulch under protected conditions for the agro-climatic region of Punjab. Therefore, double-shaded plastic mulch and genotypes PTH-1 (check) and NS-4266 are recommended to the farmers of Punjab to get maximum yield and returns from small holdings of land through protected cultivation.

Keywords: *Genotypes, Plastic mulches, Punjab, Polyhouse, Tomato, Quality, yield*

INTRODUCTION

Tomato (*Solanum lycopersicum* L) is considered the most prized and nutritious vegetable that has been a cornerstone of culinary delights and a symbol of good health for centuries [43]. Native to South America specifically Peru and Bolivia [38], having chromosome number 2n=2x=24 and well recognized as a protective food, widely cultivated worldwide for fresh consumption and processed products. It is evolved from the wild form *Solanum lycopersicum* var. *cerasiformae* and the name tomato itself comes from the Aztec word *Tomatl* which is commonly known as poor man's Orange in India, while in Europe it is known as *Poma* Peruvian-apple of Peru [34]. It is a day-neutral tropical plant that primarily self-pollinates, but some cross-pollination also takes place [40]. For optimum development and fruit setting, it requires a day temperature of 25 to 30°C and a night temperature of 15 to 20°C [11]. Higher temperature over 35°C will impair fruit setting, and fruit yield and delay the establishment of usual fruit colours [33] and [39].

Following the implementation of the green revolution, more attention is focused on product quality and production to meet growing food demands. The necessity to protect crops from unfavorable weather conditions spurred the evolution of protected cultivation. Protected cultivation addressing challenges like thunderstorms, heavy rain, and solar radiation, offers a controlled environment for tomato production. This sustainable approach maximizes vertical space and minimizes insecticide use, thus enhancing fruit yield.

The climate significantly impacts crop production and cultural practices like mulching can improve environmental conditions around the plants. Mulching, particularly in tomato crop, suppresses weed growth, reduces water use efficiency, improves soil temperature, conserves moisture, increases yield, and aids in earlier harvest. Additionally, mulching helps in reducing soil erosion and fertilizer leaching during excessive rainfall.

Research on high-yielding tomato genotypes under protected environments is limited, particularly in polyhouse cultivation and farmers face high costs and lack access to seeds. As demand for polyhouse-grown tomatoes has increased, farmers are seeking improved cultivars to meet high quantity and quality requirements.

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DOI: https://doi.org/10.58321/AATCCReview.2023.11.04.186

As farmers are not aware about the benefits of using plastic mulches and no proper information is available about which genotype(s) performs best under a particular plastic mulch and protected environment. Besides, a large number of genotypes have been evaluated for open fields, but fewer ones have been assessed for protected environments. Also, farmers have limited knowledge about the economics of production. Considering the above scenario, the current investigation was directed to check the effect of different plastic mulches on growth, yield, and quality attributes of tomato grown under polyhouse and to evaluate the most promising genotype(s) under the protected environment for the agro-climatic region of Punjab. Further, the economics of production was also worked out.

MATERIALS AND METHODS

The study was conducted during the spring-summer season of 2022-2023 under a naturally ventilated polyhouse at Vegetable Research Farm, Department of Vegetable Science, Khalsa College, Amritsar. The experiment was carried out following Factorial Randomized Block Design with three replications comprising of 15 treatment combinations which include five plastic mulch treatments *viz*., Double-shaded plastic mulch (M_1), Black plastic mulch (M_2), Red plastic mulch ($M_{3)}$, Yellow plastic mulch (M_4) and no mulch i.e. control (M_5) and three genotypes *viz*., EZ-9003 (G_1), NS-4266 (G_2) and check PTH-1 (G_3). In each block 20 plants of each genotype were planted with a spacing of 70 cm and 30 cm. Seeds of the genotypes were sown in plastic pro trays using soilless media comprising cocopeat, vermiculite and perlite in 3:1:1 proportion respectively in the last week of September and vigorous seedlings were transplanted during evening hours on well prepared beds after 35 days of sowing. Other cultural practices and plant protection measures outlined by PAU, Ludhiana were followed. Ten plants from each genotype were randomly tagged and the observations were recorded on growth, yield and quality parameters *viz*., days to 50% flowering, days to first picking, number of fruits per plant, average fruit weight (g), internodal length (cm), plant height (m), fruit yield per square meter (kg), harvest duration (days), pericarp thickness (mm), lycopene (mg/100 g), total soluble solids (°Brix), fruit shape index, titrable acidity (%) and ascorbic acid (mg/100 g). The economics of production was also worked out. The data associated with the present study was statistically evaluated in accordance with the approach R studio software (2015) (R4.3.0) at 5% level of significance.

RESULT AND DISCUSSION

Days to 50% flowering and first picking:

Earliness is a desirable trait, as the early availability of the commodity in the market benefits farmers by selling their produce at remunerative prices. Minimum days to 50% flowering was significantly noted with the treatment of double-shaded plastic mulch which was statistically at par with black plastic mulch. Although, black plastic mulch outperformed for first picking and it was statistically at par with double-shaded plastic mulch (Table 1) and mulches shorten the period of picking by 5 to 6 days as these mulches expedited the reproductive phase (flowering and fruit maturity) due to less crop weed competition, greater absorption of nutrients, optimum temperature (high photosynthetic activity) and preservation of moisture which assisted in early blooming and fruit ripening. Former investigators confirm our findings namely, [44] who discovered minimum days to 50% flowering and first picking (33.50 days and 83.20 days, respectively) under double-shaded mulch and [19] observed 33.47 days and 60.93 days, respectively.

PTH-1 (check) significantly took minimum days to 50% flowering and first picking and was statistically at par with NS-4266 for the first picking (Table 1) which might be attributable to the hybrid's higher capacity to supply assimilates to the reproductive region during the critical period ahead off flower initiation and after fruit set, as well as the congenial micro environment inside the polyhouse. Former researchers reported similar variation *viz*., [12] recorded minimum days to 50% flowering (34.68 days) and first picking (92.68 days) in line AVTO-7 and [29] stated minimum days to 50% flowering (32.33 days) and first picking (86.00 days) in Pusa Hybrid-4.

The two way interaction of Mulch (M) × Genotypes (G) was found to be non-significant. Findings of [15] backed up our result as there was no impact of different mulches with varieties on days to 50% flowering and first picking.

Internodal length (cm) and plant height (m)

Vine length and number of nodes per plant are controlled by internodal length. For higher yield, plants characterized with more number of nodes, shorter internodal length and the highest vine length are preferred. Indeterminate types of genotypes having extended vine length dominate over semi-determinate and determinate types, since they regulate fruit yield and harvest duration of crop. Significantly shortest internodal length and highest plant height was recorded from double-shaded plastic mulch being statistically at par with black plastic mulch in both the traits. Former trait performed well because of improved nutrient uptake and the accumulation of enough photosynthates at plant canopy level and the colour of mulch impacts on internodal length, indicating a potential function for the surface reflected light (especially the far-red to red light ratio) in plant growth, whereas plant height was attributed due to high canopy temperatures brought on by the double-shaded plastic mulch reflective properties, which increased photosynthetic activity and led to increased growth and development. In addition, favorable soil conditions *viz*., moisture availability, more carbohydrate assimilation, less crop-weed competition resulted in cell elongation thus ultimately increased plant height. [37] stated that mulching tomato plants with plastic film greatly affects the internodal length. The present findings are confirmed by [44] as under double-shaded plastic mulch minimum intermodal length of 6.40 cm was recorded. Earlier researches *viz*., [4] and [50] recorded 84.20 cm and 133.86 cm plant height respectively under double-shaded plastic mulch. Maximum plant height (80.00 cm) under double-shaded plastic mulch was also noted by [37].

Mean performance of genotypes revealed that minimum internodal length and maximum plant height was obtained significantly in check PTH-1 being statistically at par with NS-4266 in both the characters may be due to the genetic constitution of genotypes and modification of environment under protected structure. The findings concerning internodal length are consistent with [31] in hybrid NS-504 (10.34 cm) and [25] revealed in hybrid NS-4266 (13.86 cm). Previous researchers discovered large variability in plant height *viz*., [36] investigated in NBPGR HYD EC 165700 (476.00 cm) and BRCT-37 exhibited 493.83 cm analyzed by [7].

The two way interaction of Mulch (M) × Genotypes (G) was found to be non-significant. [18] confirmed the findings on plant height.

Number of fruits per plant

Analysis of variance disclosed that the number of fruits per plant was found to be non-significant with the treatment of plastic mulches (Table 1). However, the maximum number of fruits per plant were recorded from yellow plastic mulch. Present results are following the investigation of [48] and [28] who also discovered non-significant results for the number of fruits per plant with the treatment of different mulches.

One of the most vital attributes that must be taken into consideration is the number of fruits per plant, which is directly associated with fruit output per unit area. PTH-1 (check) significantly produced more number of fruits per plant among other genotypes because plant height was recorded maximum and internodal length was measured smallest. Our results are in the same trend with former researches *viz*., [12] reported a maximum number of fruits in AVTO-2 × AT-4 (45.40), genotype Rio Grande unveiled maximum number of fruits per plant (44.67) as reported by [2] and [21] recorded in NDT-4 × NDT Sel-3 (35.79).

The two way interaction of Mulch (M) × Genotypes (G) was found to be non-significant and it was confirmed by the results of [5] and [18] as both concluded that there was no impact on the interaction of different mulching treatments with varieties.

Average fruit weight (g) and yield per square meter (kg)

Average fruit weight is one of the imperative factors that determines the fruit yield and farmers demand fruits with maximum weight in order to maximize marketable production per plant and income. Every plant breeder's ultimate goal is to increase fruit yield. Significantly maximum average fruit weight and yield per square meter was obtained with the application of double-shaded plastic mulch and was at par with black plastic mulch for average fruit weight. Increased soil temperature, moisture conservation resulted in more photosynthesis and plentiful accumulation of CO_2 for plants. Further, a decrease in crop weed competition has boosted the availability and absorption of nutrients and water thus, consequently increased fruit growth and yield. The results of our study are supported by [9] who measured 72.40 g and [50] reported 102.84 g as both recorded maximum fruit weight with the application of double-shaded plastic mulch.[44] documented maximum average weight and fruit yield per square meter (60.20 g and 10.90 kg) under double-shaded plastic mulch.

Maximum average fruit weight and yield per square meter was significantly measured in NS-4266. The better performance for fruit weight was ascribed to more accumulation of nutrients and water inside the locules as a result of genetic constitution of the genotype and suitable environmental conditions inside the polyhouse, whereas highest yield per square meter was attributed due to maximum average fruit weight and better micro-climate inside the protected structure. Increase in the thickness of the exocarp layer might be another reason that resulted in heavier fruits. Variations in average fruit weight were also disclosed by [10] in the Punjab Sartaj (84.08 g) and NDT-4 × NDT Sel3 (92.34 g) as discovered by [21]. For fruit yield per square meter following researchers approved our findings *viz*., [13] in Palam Pride (15.00 kg/m^2) and [25] recorded in Heemsona (22.10 kg/m^2).

The two way interaction of Mulches (M) × Genotypes (G) was found to be non-significant. Present study is in conformity with the findings of [5] and [18] as there was no impact of different mulches with varieties on the average fruit weight and yield per square meter.

Harvest duration

Prolonged harvest duration is an essential attribute to ensure regular delivery of produce to the market for a longer period of time to avoid market oversupply and extended harvest days also assures higher yield thus leads to earn more monetary value. Double-shaded plastic mulch surpassed other mulches and being statistically at par with black plastic mulch due to optimum growing conditions, less nutrient leaching, more water conservation and optimum warmness, thus led to higher photosynthetic activity which directly resulted in transfer of assimilates for more days, thus leading to the extension of harvesting days. The findings of the research are backed up by [44].

Among other genotypes, significantly maximum harvest duration was characterized in PTH-1 ascribed to favorable environmental settings inside the polyhouse and difference in genotype's hereditary makeup which as a result transported photosynthates for a prolonged period of time, thus leading to the extended period of harvesting. These variations for harvest duration had also been reported by [32] in variety Ratan (116.00 days) and [14] noted in genotype Black Cherry (136.00 days).

Non-significant difference was observed in two-way interaction of Mulch (M) × Genotypes (G).

Pericarp thickness (mm)

Pericarp thickness is an imperative trait that is necessary for longer storage period and high transportation capabilities. Observations measured on pericarp thickness reveal that plastic mulches had non-significant impact in fluctuating the pericarp thickness of tomato (Fig. 1). However, maximum pericarp thickness was measured from the fruits harvested under the treatment of red plastic mulch. [6] and [44] also had non-significant results for pericarp thickness in indeterminate tomatoes.

It is apparent from the data that in comparison to check PTH-1, significantly maximum value of pericarp thickness was possessed by genotype NS-4266 in view of the fact that favourable environmental surroundings inside the polyhouse suits genotype which as a result increased the number of cells thus thickened the fruit pericarp. The findings are assisted by [46] who recorded maximum pericarp thickness in hybrid TODD VAR-8 (5.47 mm) and [21] affirmed maximum pericarp thickness in 2012/TOLCVRes-1 (5.34 mm).

The two-way interaction of Mulch (M) × Genotypes (G) was found to be non-significant. Present outcomes are in unity with findings of [20].

Lycopene (mg/100 g)

Lycopene is a potent antioxidant that contributes to the red color of tomatoes thus affecting its quality. Maximum lycopene content was significantly obtained under double-shaded plastic mulch being statistically at par with black and red plastic mulch due to enhanced metabolic processes of the plant (increasing chemical composition of the fruits) in mulched plots. Results correspond to an earlier study by [41] who recorded maximum lycopene (6.90 mg/100 g) and [16] obtained 2.99 mg/100 g.

Mean performance for different genotypes revealed that NS-4266 acquired maximum content of lycopene (Fig. 1) as compared to check PTH-1 due to the optimum temperature and other climatic variables inside the polyhouse during its colour development and pigmentation. Former researchers also discovered similar results specifically, [12] documented in line

AVTO-2 (4.68 mg/100 g) and [24] too confirmed in hybrid Punjab Gaurav (4.70 mg/100 g).
The two-way interaction between Mulch (M) and Genotypes (G) on lycopene content was non-significant.

Total soluble solids (°Brix)

Total soluble solids is a very significant quality parameter and it determines the degree of sweetness. Significantly maximum TSS was measured in red plastic mulch which was statistically equivalent with black plastic mulch and double-shaded plastic mulch (Fig. 1) as red and far red light is collected by phytochrome [17] which causes a sequence of chemical changes, including fruit sweetness. The findings of former investigators confirm our result as [1] measured 6.94 °Brix and [26] noted maximum total soluble solids (5.98 °Brix) with the application of red plastic mulch.
In the present study it was observed that significantly highest TSS was found in check PTH-1 due to variations in the genetics of the genotype and surrounding environment that dominated during the growing period as well as the ability of a genotype to provide assimilates during the quality enhancement phase. Many prior studies noticed substantial variation among tomato genotypes for this trait *viz*., [22] recorded maximum TSS in INDAM-3003 (5.36 °Brix) and [24] obtained in Punjab Sartaj (5.77 °Brix).
The two-way interaction between Mulch (M) and Genotypes (G) was not significant. Present findings are in conformity with the results of [42].

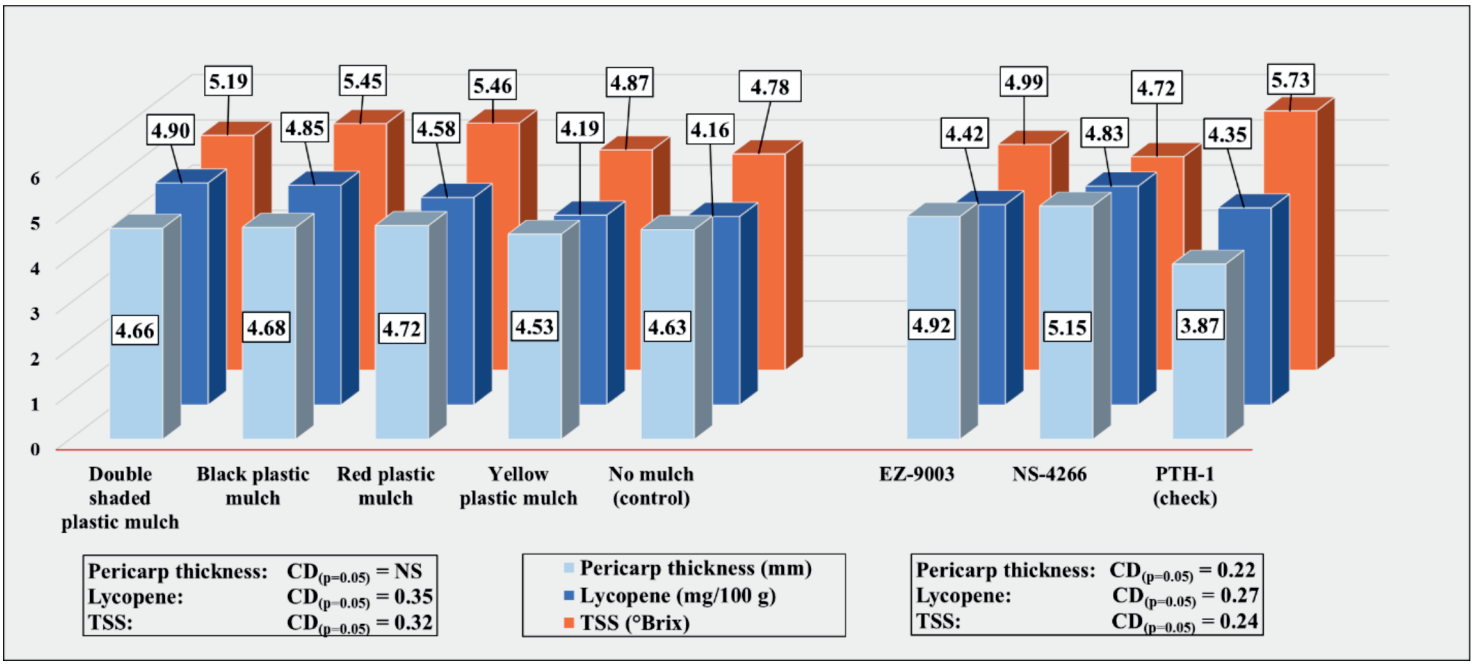

Fig. 1 Effect of mulches and mean performance of genotypes for pericarp thickness (mm), lycopene (mg/100 g) and TSS (°Brix) under protected environmen

Fruit shape index (P/E)

Fruit shape index is an important attribute from a market point of view. Certain markets prefer fruits that are round or flat in shape, others choose pear-shaped or oval fruits. Fortunately, consumers in Punjab prefer oval-round to flat fruits. In the current study, non-significant variations were recorded for fruit shape index in different plastic mulches (Table 2). Among all the mulching treatments including control, flat round shaped fruits were obtained. Following former researchers also stated non-significant results *viz*., [30] and [44].
Comparing the mean performance of genotypes, check PTH-1 was round in shape while EZ-9003 and NS-4266 were flat round in shape. This parameter is steady and not inclined by environmental stresses. Variation in fruit shape index totally depends upon the genes of genotype and administered by cell size and the intercellular space of the flesh. In the same way, tomato genotypes were also classified into oval, spherical, round, and flat round categories in prior studies as [47] and [10] testified that the Cochoro variety and Punjab Gaurav have oval shape (1.15 and 1.16 respectively), whereas other two entries are round in shape i.e. Punjab Sartaj (0.93) and G-600 (0.89) and [13] affirmed that Roma (1.30), Bt-20-3 (Yellow Egg Shape) (1.22) and Punjab Chhuhara (1.33) were oval in shape.
The two-way interaction between mulch and genotypes was non-significant and our findings are similar with [49].

Titrable acidity (%) and Ascorbic acid (mg/100 g):

Tomato fruits with minimum titrable acidity are preferred for table purpose, but higher acidity is required for the processing industry as microbial activity in processed products is inhibited by high acidity. Hence, fruits of both categories had value in the market. Ascorbic acid content plays an important role in the human body as it is related to the nutritional point of view because vitamin C aids in growth and repair of tissues. Significantly maximum titrable acidity was obtained with the application of black plastic mulch which was at par with double-shaded plastic mulch due to the stimulatory effect on plant development and metabolism, which resulted in enhanced chemical composition. Although minimum titrable acidity was obtained under control plot (Table 2). The ascorbic acid content was recorded significantly maximum in black plastic mulch. The conclusion of our results is in similar trend with [27] who recorded maximum acidity (0.48%) under black mulch and many researchers also depicted similar findings for ascorbic acid, namely [27] recorded 27.60 mg/100 g and [44] noted 32.77 mg/100 g. In addition, [3] recorded the maximum ascorbic acid (123.01 mg/100 g) in chilli under black plastic mulch.
The maximum value for titrable acidity and ascorbic acid content was noticed in EZ-9003 due to difference in genes of the genotype and optimal microclimate that reside during the fruit

formation phase, whereas the minimum value of titrable acidity was noticed in check PTH-1. Similar results were obtained as [29] stated that Arka Meghali acquired maximum titrable acidity (0.77%), whereas minimum acidity was obtained in EC 620445 (0.56%) and [21] affirmed that NDT-4 × NDT Sel-3 had maximum acidity (0.46%), whereas minimum acidity was recorded in NDT-4 (0.36%). Findings of ascorbic acid are backed up by former investigators *viz*., [13] who noted maximum ascorbic acid in Bt-20-3 (27.19 mg/100 g), line 2019/TOLCV Res-4 performed best (21.67 mg/100 g) as reported by [21] and [23] reported in line IRS-43-2 (31.00 mg/100 g).

The two-way interaction between Mulch (M) and Genotypes (G) on titrable acidity was non-significant (Table 2). Present findings are in conformity with the findings of [47]. Significant differences were observed for ascorbic acid content (Fig. 2). Maximum ascorbic acid was recorded from NS-4266 raised with black plastic mulch (M_2 × G_2) because of favorable polyhouse conditions and the better response of the hybrid's genetic makeup towards the black plastic mulch as it enhanced the growth, development, and metabolic processes, thus subsequently increased the chemical composition.

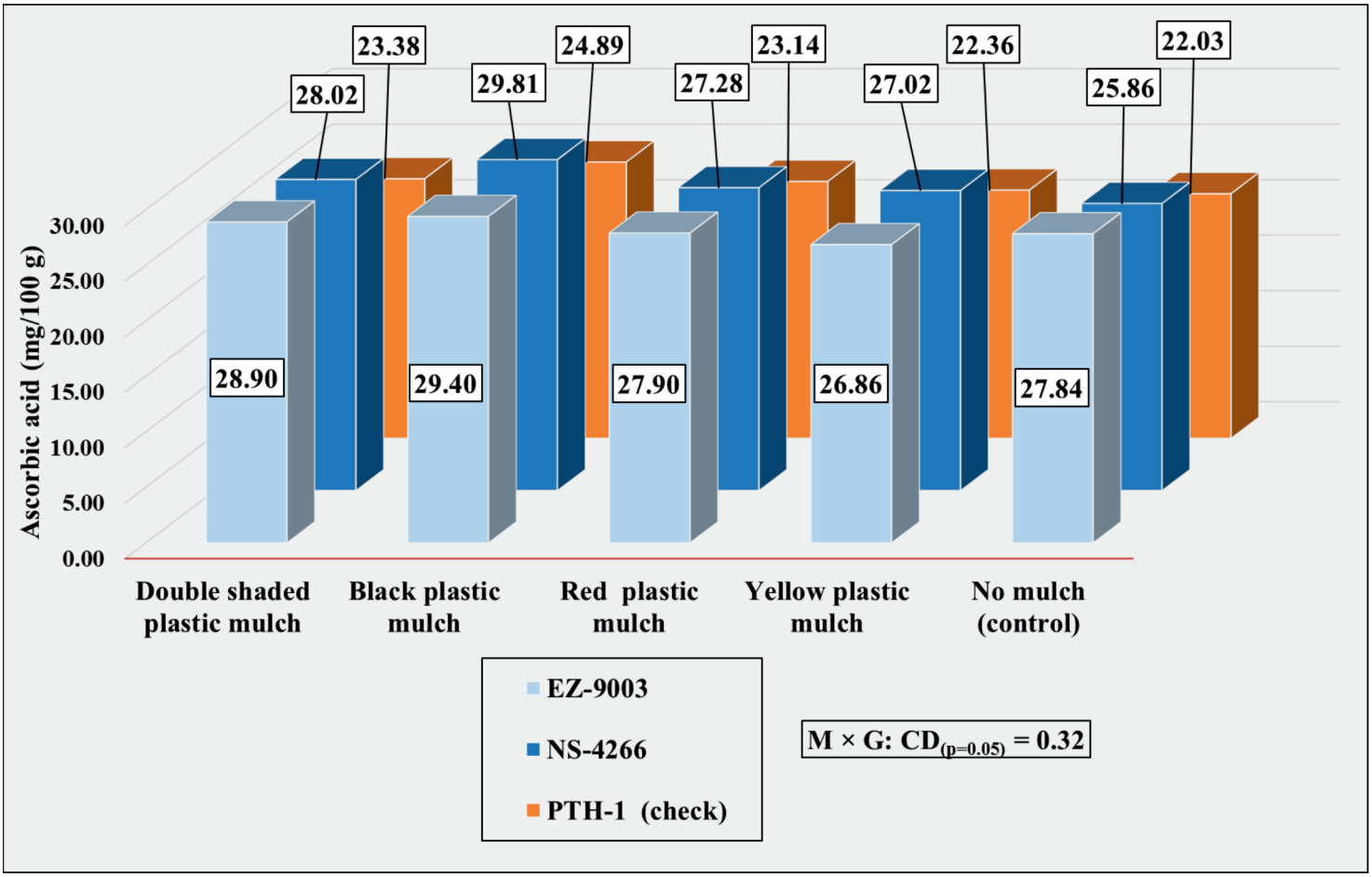

Fig. 2 Two-way interaction of Mulch (M) × Genotypes (G) on ascorbic acid content Economic studies:

Technology adoption in modern agriculture will only be practicable and acceptable to farmers if it is economically profitable and this parameter will assist farmers in further refining the monetary value of cultivating tomato crop under protected conditions. Net returns was significantly maximum under double-shaded plastic mulch. Although, B: C ratio was also maximum under double-shaded plastic mulch and statistically at par with black plastic mulch because of its superior outcomes with respect to yield and its related traits which result in increment of net returns, thus leading to the highest profit. [44] obtained 147.60 Rs./m^2 and 3.10 respectively, [50] attained 3,15,555 Rs./ha and 2.87 and [35] recorded 3,92,048 Rs./ha and 2.40 with the treatment of double-shaded plastic mulch in tomato.

The introspection on mean performance of tomato genotypes under polyhouse reveals that NS-4266 governs maximum net returns and B: C because of its maximum yield per square meter which resulted in more profit by selling the produce in the market. Former researchers *viz*., [8] and [45] obtained maximum B: C ratio in varieties BARI Tomato 15 (2.21) and hybrid Dev (2.27) respectively.

The analysis of variance reveals that the interaction effect between Mulch (M) and Genotypes (G) was non-significant.

CONCLUSION

From the findings of the study, it was concluded that among the different mulch treatments, double-shaded plastic mulch performed well for all growth and yield contributing traits except days to first picking. For quality attributes both red and black plastic mulches were proved to be the best treatments. However, on the basis of mean performance of genotypes, it was affirmed that PTH-1 (check) and NS-4266 provides the best outcomes for growth, yield and development which were accomplished under polyhouse condition due to the favorable climatic conditions *viz*., temperature and relative humidity which positively influenced the morpho-phenological and physiological measures of tomato plants. NS-4266 can be cultivated for maximum transportation ability due to thickest pericarp thickness, while check PTH-1 and genotype EZ-9003 can be opted for processing purpose. From the nutritional point

of view, EZ-9003 proved to be best as it exhibited maximum ascorbic acid content. Highest net returns and B: C ratio was obtained in genotype NS-4266 and double-shaded plastic mulch, thus found most suitable for commercial cultivation of tomato under polyhouse conditions for the agro-climatic region of Punjab.

FUTURE PROSPECTS

In future, small farmers are increasing day by day, but on the contrary, agricultural land for cultivation is shrinking. So, in order to meet the demands for quality and bulk food, protected cultivation is the only future to fulfil the needs of society. In addition, mulching is another approach which positively influences yield and quality of produce. In the present era, consumers are getting more conscious and demanding higher quality food. So, to meet the consumer demands, cultivation of crops under the protected environment utilizing plastic mulches is a successful approach of supplying quality produce. Hence, to maximize monetary gains under the protected environment, Palam Tomato Hybrid-1 and NS-4266 along with double-shaded plastic mulch are suggested to the farmers of Punjab.

AUTHOR'S CONTRIBUTION

Conceptualization of research work and experimental design (Ashish Sharma, Navjot Singh Dhillon); Field/lab experiment execution and data collection (Ashish Sharma, Navjot Singh Dhillon); Data analysis and interpretation (Ashish Sharma, Navjot Singh Dhillon); Manuscript preparation (Ashish Sharma, Navjot Singh Dhillon, Mamta, Gurmehakdeep Singh, Guravtar Singh).

DECLARATION

All the authors of this research paper declare no conflict of interest.

ACKNOWLEDGEMENT

The authors are grateful to the Department of Horticulture, Khalsa College, Amritsar for providing all the necessary facilities during the research.

Table 1: Effect of plastic mulches and mean performance of tomato genotypes under protected environment

M_1: Double-shaded plastic mulch, **M_2:** Black plastic mulch, **M_3:** Red plastic mulch, **M_4:** Yellow plastic mulch, **M_5:** No mulch (control) and **G_1:** EZ-9003, **G_2:** NS-4266, **G_3:** PTH-1 (check)

Parameters → / Treatments ↓		Days to 50% flowering	Days to first picking	Number of fruits per plant	Average fruit weight (g)	Internodal length (cm)	Plant height (m)	Fruit yield per square meter (kg)	Harvest Duration (Days)
Mulches (M)	M_1	36.62	78.25	43.43	87.34	12.18	4.37	17.86	115.50
	M_2	38.34	76.95	41.88	83.37	12.89	4.21	16.50	113.17
	M_3	39.61	80.64	42.12	77.47	13.82	4.00	15.45	110.42
	M_4	41.13	81.71	43.99	71.56	15.23	3.71	14.83	108.62
	M_5	43.06	83.67	41.12	65.92	15.87	3.60	12.78	104.81
	$CD_{(p=0.05)}$	**2.86**	**2.04**	**NS**	**6.50**	**1.69**	**0.32**	**0.83**	**4.35**
Genotypes (G)	G_1	47.78	86.24	37.56	76.06	15.00	3.53	13.47	105.12
	G_2	37.61	77.88	42.90	84.10	13.89	4.15	17.12	110.10
	G_3	33.86	76.61	47.06	71.24	13.10	4.26	15.87	116.29
	$CD_{(p=0.05)}$	**2.21**	**1.58**	**3.37**	**5.03**	**1.30**	**0.25**	**0.65**	**3.37**
Interaction (Mulch × Genotypes)	**$CD_{(p=0.05)}$**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 2: Effect of mulches and mean performance of genotypes on quality attributes and economics of cultivation

M_1: Double-shaded plastic mulch, **M_2:** Black plastic mulch, **M_3:** Red plastic mulch, **M_4:** Yellow plastic mulch, **M_5:** No mulch (control) and **G_1:** EZ-9003, **G_2:** NS-4266, **G_3:** PTH-1 (check)

Parameters → / Treatments ↓		Fruit shape index	Titrable acidity (%)	Ascorbic acid (mg/100 g)	Net returns (Rs./m²)	B: C ratio
Mulches (M)	M_1	0.84	0.73	26.77	398.39	2.89
	M_2	0.84	0.79	28.03	362.39	2.73
	M_3	0.85	0.54	26.11	327.99	2.41
	M_4	0.86	0.59	25.41	315.49	2.43
	M_5	0.85	0.45	25.44	265.05	2.23
	$CD_{(p=0.05)}$	**NS**	**0.10**	**0.52**	**25.16**	**0.19**
Genotypes (G)	G_1	0.78	0.70	28.18	273.20	2.07
	G_2	0.81	0.59	27.59	382.57	2.90
	G_3	0.96	0.57	23.16	345.76	2.64
	$CD_{(p=0.05)}$	**0.04**	**0.07**	**0.40**	**19.49**	**0.15**
Interaction (Mulch × Genotypes)	**$CD_{(p=0.05)}$**	**NS**	**NS**	**0.91**	**NS**	**NS**

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