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Influence of preharvest fruit bagging on yield and economics of grape cv. crimson seedless

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Abstract
This investigation entitled "Influence of Preharvest Fruit Bagging on Yield and Economics of Grape cv. Crimson Seedless" was carried out during 2024-2025 at Sector No. 70, Grape Orchard, Main Horticultural Research and Extension Centre, University of Horticultural Sciences, Bagalkot. The experiment consisted of twelve treatments, each replicated three times, involving different types of fruit bags to assess their influence on yield and quality attributes of grapes. The trial was laid out in a randomized completely block design (RCBD). Bagging was imposed when the berries attained a size of approximately 6-7 mm, and all bags were removed one week prior to harvest. Among the various treatments, the use of white non-woven polypropylene bags was found to be the most effective, recording the highest bunch volume, bunch weight, berry diameter, berry weight and berry length, along with maximum net returns. Overall, fruit bagging significantly improved yield and economic gains of Crimson Seedless grapes compared to the unbagged control.

Keywords: Grape, crimson seedless, fruit, bagging, yield, quality

Introduction

The grape (*Vitis vinifera* L.) is one of the most economically important fruit crops of the world and occupies a prominent position among India's commercial fruit crops. In India, grapes are cultivated over an area of about 164 thousand hectares with an annual production of 3.40 million tonnes, contributing nearly 2.7 % to the total fruit production of the country (NHB, 2023). Maharashtra is the leading producer, accounting for about 70 % of the total grape production, followed by Karnataka, Tamil Nadu, and Andhra Pradesh. Grapes are primarily grown for fresh consumption as table grapes, while a considerable portion is used for raisin and wine making.

Despite their commercial importance, table grapes are highly perishable due to their tender skin, high moisture content and susceptibility to fungal infections such as *Botrytis cinerea*. Post-harvest losses and poor berry appearance significantly affect marketability and export potential (Pongener *et al.*, 2024) [15]. In addition to post-harvest measures, pre-harvest strategies such as fruit bagging have gained considerable attention as a simple, eco-friendly practice to enhance fruit quality and reduce pesticide residues.

Fruit bagging involves enclosing developing clusters in various bag materials (e.g., non-woven polypropylene, paper, newspaper, or nylon) during the maturation period. This micro-environment modifies light intensity, temperature and humidity around the bunch, thereby influencing berry size, color development and overall quality (Hwang *et al.*, 2004) [9]. Bagging acts as a physical barrier against insect pests, dust, bird injury and sunburn, while also minimizing mechanical damage and pesticide exposure (Wei *et al.*, 2020) [18].

Studies have reported that bagging can enhance anthocyanin accumulation, improve berry uniformity, and reduce fruit cracking and disease incidence, depending on the bag type and cultivar (Pongener *et al.*, 2024) [15]. The practice has therefore become an important part of sustainable grape production aimed at improving visual appeal and extending market shelf life without relying heavily on chemical treatment.

Materials and Methods

The experimental study entitled with "Influence of preharvest fruit bagging on yield and quality parameters of grape cv. Crimson Seedless" was carried out in the year 2024-2025 located in Main Horticultural Research and Extension Centre (MHREC), Sector no. 70, Grape orchard, Division of fruit science, University of Horticultural Sciences, Bagalkot. The experimental plot is situated at Main Horticultural Research and Extension Centre (MHREC), Sector 70, Grape orchard, Division of fruit science, University of Horticultural Sciences, Bagalkot. Location is in Northern dry region of Karnataka geographically situated 16^0 10' North latitude, 75^0 42' East longitude and elevated at an altitude of 542 m above Mean Sea Level (msl). The experimental design laid out is Randomized Block Design (RBD) with twelve treatments and three replications.

Bagging treatments were imposed when grape berries attained a size of 6-7 mm, and the bags were removed one week before harvest. Treatment T_1 served as the control (without bagging). Treatment T_2 consisted of white-coloured non-woven polypropylene bags, T_3 of blue-coloured non-woven polypropylene bags, T_4 of yellow-coloured non-woven polypropylene bags, T_5 of red-coloured non-woven polypropylene bags, T_6 of green-coloured non-woven polypropylene bags, T_7 of black-coloured non-woven polypropylene bags and T_8 of pink-coloured non-woven polypropylene bags. In addition, T_9 included white paper bags, T_{10} brown paper bags, T_{11} newspaper bags and T_{12} nylon bags Bagging was performed on healthy, uniform bunches free from blemishes, with five bunches maintained per vine to ensure uniform growth. All bags were perforated and cut at the bottom for aeration, except nylon mesh bags. The bag materials included newspaper (15 × 18 inches), brown paper (8 × 10 inches), white paper (8 × 10 inches), non-woven polypropylene bags (16 × 20 inches) and nylon mesh (12 × 18 in) bags. Bags were securely stapled to avoid insect entry and damage from rain or wind. Periodic checks were made to ensure proper bunch development and to replace any torn or displaced bags. This technique helped maintain fruit quality and protected bunches throughout development. Some of the observations recorded are as follows:

Bunch weight (g)

The mean weight of bunch was derived by averaging of five bunches weight during harvest.

Bunch volume (cm^3)

The volume of harvested bunches was determined by dipping bunches in volumetric beaker having full of water by measuring the volume of water overflowed using a volumetric cylinder. It was expressed in cubic centimetre.

Berry length (mm)

Mean length of berry obtained by measuring six berries with the help of digital vernier callipers and was expressed in millimetre (mm).

Berry diameter (mm)

The same berries which were used for measuring length was measured at its maximum width using digital vernier calliper, the mean berry diameter was expressed in terms of millimeter (mm).

100-Berries weight (g)

The weight of 100-berries was determined by randomly selecting 100 berries from each of three bunches across all treatments with regard to replications. These berries were weighed using a digital balance and their average weight is expressed in grams (g).

Yield per vine (kg/vine)

The mean bunch weight was multiplied by average number of bunches per vine to get yield per vine and expressed in kilogram.

Yield per hectare (t/ha)

Estimated yield (t/ha) was obtained by multiplying yield (kg/vine) with total number of vines per hectare.

Economics of the system

The BC ratio for different treatments was worked out based on the expenditure and income in order to study the economics of grape production.

$$\text{Benefit to cost ratio} = \frac{\text{Gross income (Rs. per hectare)}}{\text{Total cost of cultivation (Rs. per hectare)}} \times 100$$

Results and Discussion

The largest bunch volume was obtained in T_2 (281.33 cm^3), however the lowest bunch volume was observed in T_1 (192.61 cm^3) (Table 1), while maximum bunch weight was obtained in T_2 (360.27 g) and minimum in T_1 (234.99 g). Significant variation was observed among treatments with respect to bunch volume and weight illustrated in Table 1. Bagging might have altered the microclimatic conditions surrounding the developing grape bunch, influencing temperature, humidity and light intensity, which in turn affect various physiological and biochemical processes within the berries. Such modifications often lead to improved berry size and quality attributes compared to non-bagged fruits. The lower temperature prevailing inside the bag reduces chlorophyll degradation and inhibits the GA_3 degrading enzyme activity. Therefore, the increase in bunch volume as well as weight could be attributed to the inhibition of GA_3 degrading enzyme activity and the optimal light penetration, as reported by Kiran *et al.* (2020) [12] in cv. Muscat Hamburg. These findings are in agreement with the observations of Alebidi *et al.* (2024) in date palm, where similar microclimatic effects under bagging enhanced fruit development and size.

The maximum berry length was recorded in T_2 (18.23 mm), in contrast the minimum berry length was observed in T_1 (15.80 mm). The highest berry diameter was noted in T_2 (14.96 mm), whereas the lowest berry diameter was observed in T_1 (12.34 mm). Marked differences were recorded in 100-berries weight across the treatments as presented in Table 2. The highest 100-berries weight was observed in T_2 (266.05 g), however the lowest weight was registered in T_1 (211.81 g). It was evident from the results that T_2 which was white non-woven polypropylene bag showed better performance than other treatments which led to the highest berry length, diameter and berry weight.

According to Xu *et al.* (2008) [20], bagging creates a favourable microclimate for fruit growth and development, which could be the reason for the berry's increased weight and size. Auxin and light may have an unforeseen effect on improved bunch characteristics, according to recent data light that reaches through the bags modulates the grape berry's tissue-level auxin content and is in position to regulate cell elongation, which leads to larger berries. Compared to the bags of other colours, white bags may have a higher light penetration rate. (Fankhauser and Fiorucci, 2017) [8]. Additionally, these outcomes roughly correspond with the findings of Kiran *et al.*, 2020 [12] in grapes, Debnath and Mitra (2008) [7] in litchi and Srivastava *et al.*, 2020 [19] in Guava.

The productivity of grape vines is influenced by a combination of growth parameters, physiological efficiency and favourable environmental conditions, which collectively determines yield. In this research there was significant variation among different treatments with respect to yield (Table 3). The highest yield was recorded in treatment T_2 (10.13 kg/vine and 22.52 t/ha). Bagging with white non-woven polypropylene bag created a microclimate by diffusing light and regulating temperature, which enhances chlorophyll activity and photosynthate supply to developing berries. This increases cell division and cell expansion in the pericarp, leading to a higher berry size, berry weight and ultimately greater yield. In contrast, the lowest yield was observed in T_1 (8.36 kg/vine and 18.58 t/ha) these findings are in line Abou El-Wafa *et al.* (2014) in pomegranate fruit and Kiran *et al.*, 2020 [12] in grape cv. Muscat hamburg. Also, Barman and Choudhury (2022) [5] observed that pre-harvest bagging with white non-woven bags enhanced yield in litchi.

Benefit: Cost ratio

The data on benefit: cost ratio of grapes cv. Crimson Seedless as influenced by different pre-harvest bagging materials are presented in Table 4. The highest B:C ratio (2.29) was observed in T_2, while the lowest was recorded in T_1 (1.89). The increased benefit: cost ratio in T_2 may be attributed to improved yield per vine and yield tonnes per hectare, bunch weight and better berry quality that enhanced marketable returns. The white non-woven polypropylene bags provided a favourable microclimate by maintaining aeration, moderating temperature and reducing pest and disease incidence. These advantages improved berry appearance and reduced postharvest losses, ultimately resulting in maximum economic gain. Similar findings were reported by Afsar and Sultana (2019) [4] in mango and Singh *et al.* (2022) [17] in litchi and Medaboina *et al.*, 2024 [14] in mango, where bagging treatments recorded higher B:C ratios due to improved fruit quality and marketable yield compared to unbagged treatments.

Table 1: Bunch weight and volume in grape cv. Crimson Seedless as influenced by preharvest fruit bagging

Treatment	Bunch weight (g)	Bunch volume (cm^3)
T_1	234.99	192.61
T_2	360.27	281.33
T_3	280.67	212.33
T_4	317.60	238.33
T_5	334.80	241.33
T_6	294.00	214.00
T_7	241.27	198.67
T_8	295.27	182.67
T_9	259.73	202.33
T_{10}	307.27	233.00
T_{11}	351.40	269.67
T_{12}	337.40	254.33
S.E.m ±	6.84	4.18
CD at 5 %	20.05	12.26

Table 2: Berry length, berry diameter and 100 berries weight in grape cv. Crimson Seedless as influenced by preharvest fruit bagging

Treatment	Berry length (mm)	Berry diameter (mm)	100 berries weight (g)
T_1	15.80	12.34	211.81
T_2	18.23	14.96	266.05
T_3	17.14	13.22	227.17
T_4	17.08	13.29	247.66
T_5	17.11	13.77	251.91
T_6	17.10	13.63	235.02
T_7	16.19	12.54	215.31
T_8	16.90	13.92	244.27
T_9	16.69	13.75	232.51
T_{10}	16.45	14.31	241.98
T_{11}	17.78	14.69	260.74
T_{12}	17.14	13.90	252.44
S.E.m ±	0.33	0.33	4.47
CD at 5 %	0.96	0.97	13.11

Table 3: Yield as influenced in grape cv. Crimson Seedless by preharvest fruit bagging

Treatment	Yield (kg/vine)	Yield (t/ha)
T_1	8.36	18.58
T_2	10.13	22.52
T_3	8.43	18.73
T_4	9.13	20.30
T_5	9.59	21.30
T_6	8.71	19.36
T_7	8.37	18.61
T_8	9.05	20.11
T_9	8.42	18.72
T_{10}	9.11	20.24
T_{11}	10.06	22.36
T_{12}	9.60	21.34
S.Em ±	0.25	0.37
CD at 5 %	0.69	1.08

Table 4: Economics of grape cv. Crimson Seedless as influenced by preharvest fruit bagging

Treatment	Yield (t/ha)	Cost of cultivation	Cost of bagging	Gross return `/ha	Net return `/ha	B:C ratio
T_1	18.58	472100	16,665	8,91,840	4,19,740	1.89
T_2	22.52	4,88,765	16,665	1,080,960	5,92,195	2.29
T_3	18.73	4,88,765	16,665	8,99,040	4,10,275	1.90
T_4	20.3	4,88,765	16,665	9,74,400	4,85,635	2.06
T_5	21.3	4,88,765	16,665	1,022,400	5,33,635	2.17
T_6	19.36	4,88,765	16,665	9,29,280	4,40,515	1.97
T_7	18.61	4,88,765	16,665	8,93,280	4,04,515	1.89
T_8	20.11	4,88,765	16,665	9,65,280	4,76,515	2.04
T_9	18.72	5,05,430	33,330	8,98,560	3,93,130	1.90
T_{10}	20.24	5,05,430	33,330	9,71,520	4,66,090	2.06
T_{11}	22.36	4,73,100	1,000	1,073,280	6,00,180	2.27
T_{12}	21.34	6,60,970	1,88,870	1,024,320	3,63,350	2.17

Conclusion

Findings from this investigation indicate that preharvest fruit bagging had a substantial impact on both yield as well as economics of grape cv. Crimson Seedless. Among the treatments tested, white non-woven polypropylene bags proved to be the most effective, ensuring superior berry development, increased yield and economic gains. The study highlights that the choice of bagging material plays a decisive role in determining the final quality and protection of grapes. White non-woven polypropylene bags can be strongly recommended for improving overall yield.

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