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Impact of Rootstock Selection and Cane Regulation on the Organoleptic Characteristics of Wine

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ABSTRACT

An investigation was conducted to assess the impact of rootstock selection and cane regulation on the organoleptic characteristics of wine in the semi-arid region of Karnataka. The study was carried out during 2022-2024 at the Main Horticultural Research and Extension Centre, Bagalkot, using a split-split plot design with two rootstocks (R_1: Dogridge and R_2: 110 R), five grape varieties (V_1: Cabernet Sauvignon, V_2: Medica, V_3: Shiraz, V_4: Sauvignon Blanc and V_5: Chenin Blanc), and three cane regulation levels (C_1: control, C_2: 36 canes/vine and C_3: 24 canes/vine). Organoleptic properties, including appearance, aroma, taste, and overall acceptability, were evaluated using a 20-point hedonic scale over two years and pooled data. Results revealed significant differences among treatments. Rootstock R_2 consistently recorded higher scores across all organoleptic parameters, with pooled appearance and aroma scores of 17.90 and 18.16, respectively, compared to R_1. Among varieties, V_2 exhibited superior performance, with the highest pooled appearance (17.47) and aroma (17.31) scores, followed by V_3 and V_1. Cane regulation influenced appearance but had a non-significant effect on aroma, with C_3 recording the highest pooled scores for appearance (15.78) and aroma (16.13). Interaction effects were significant, with the combination $R_2V_2C_3$ achieving the highest scores for both appearance (20.68) and aroma (20.05). The findings demonstrate that rootstock 110 R, Medica variety, and a 24-cane regulation approach significantly enhance the sensory quality of wine in semi-arid conditions. These results emphasize the importance of integrating rootstock selection and cane regulation to optimize wine quality. The study provided valuable insights for viticultural practices in similar agro-climatic regions, contributing to sustainable and high-quality wine production systems.

Keywords:Cane regulation, Organoleptic characteristics, Rootstock, Selection, Wine quality.

INTRODUCTION

Grape cultivation is considered to be an economic venture for the farmers due to its high monetary returns both from its fruits and processed products like wine (Kaur *et al,* 2021). The production of wine from fruits of grape is an intricate process, where the quality and sensory attributes of the final product are greatly influenced by viticultural practices. Organoleptic evaluation, encompassing the sensory parameters of appearance, aroma, taste, and mouthfeel, plays a crucial role in determining the acceptability and market value of wine. Factors such as rootstock selection and cane regulation are pivotal in shaping these sensory characteristics, as they influence the growth, yield, and chemical composition of grape berries, which, in turn, impact the wine's quality and sensory profile. Rootstocks contribute to the vine's tolerance to biotic and abiotic stresses, nutrient uptake, and overall vine vigor (Singh *et al,* 2025), which directly affect the accumulation of phenolic compounds, organic acids, and sugars in the grape berries which are the key determinants of wine's organoleptic properties. Cane regulation, primarily through pruning intensity, alters the vine's canopy structure, light interception, and the balance between vegetative and reproductive growth. This influences the development of flavour precursors and secondary metabolites that enhance wine aroma, taste, and mouthfeel. (Kiran *et al,* 2019). This study was

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undertaken to assess the organoleptic properties of wine produced from five grape varieties grown on two rootstocks and subjected to three levels of cane regulation. By evaluating the appearance, aroma, taste, and overall acceptability of wine over two years and pooled data, the study aimed to identify significant differences and interactions among the treatments and determine the most favourable combinations for enhancing wine quality. The research holds immense relevance for viticulture practices in regions like Karnataka's northern dry zone, where managing environmental and climatic challenges is critical for producing high-quality wine. The findings are expected to provide valuable insights into optimizing rootstock selection and cane regulation to improve the sensory attributes of wine, contributing to the advancement of sustainable and high-quality wine production systems.

MATERIALS AND METHODS

The investigation on "Influence of rootstock and cane regulation on growth, yield, and quality of wine grapes" was conducted during 2022-2024 at MHREC, Block J1, UHS, Bagalkot (16° 9' N, 75° 37' E, 542 m MSL) in the northern dry zone of Karnataka. The experiment used a split-split plot design with 30 treatments replicated three times. Spacing was 9 ft × 4 ft. The main treatments were rootstocks (Dogridge and 110 R), sub-treatments were cultivars (Cabernet Sauvignon, Medica, Shiraz, Sauvignon Blanc and Chenin Blanc), and sub-sub treatments were cane regulation levels (C_1: Control, C_2: 36 canes/vine and C_3: 24 canes/vine). Data were recorded on randomly selected plants. Wine samples were organoleptically analyzed using a 20-point hedonic scale (appearance, aroma, taste, colour, overall acceptability) by 10 panel members, following standard wine-tasting procedures (Veena *et al,* 2015).

Hedonic scale:

18-20 excellent	15-17 good	12-14 fair	
9-11 ordinary	6-8 poor	3-5 bad	1-2 very bad

RESULTS AND DISCUSSION

Organoleptic evaluation of appearance

The organoleptic evaluation of appearance in 2023, 2024, and in pooled data showed significant differences due to rootstocks (Table 1). In pooled data, rootstock R_2 recorded significantly higher appearance scores (17.90) compared to rootstock R_1 (12.94). The variation in appearance scores due to varieties was significant as well. Variety V_2 exhibited the highest appearance score (17.47), followed by V_3 (16.46) and V_1 (15.55). The lowest appearance score was recorded by variety V_5 (12.91). Cane regulation also had a significant effect on appearance. In pooled data, cane C_3 showed the highest appearance score (15.78), followed by C_2 (15.40), and the control C1 (15.09). The interaction between rootstocks, varieties, and cane regulation influenced the organoleptic evaluation of appearance significantly. In pooled data, the treatment combination $R_2V_2C_3$ recorded the highest appearance score (20.68), followed by $R_2V_2C_2$ (20.15) and $R_2V_3C_3$ (19.23).

Organoleptic evaluation of aroma

The aroma evaluation in 2023, 2024, and in pooled data showed significant differences due to rootstocks (Table 1). In pooled data, rootstock R_2 recorded significantly higher aroma scores (18.16) compared to rootstock R_1 (13.42). The variation in aroma scores due to varieties was significant. Variety V_2 had the highest aroma score (17.31), followed by V_3 (16.63) and V_1 (16.05). The lowest aroma score was recorded by variety V_5 (13.62). Cane regulation had a non-significant effect on aroma during 2023, 2024, and in pooled data. In pooled data, cane C_3 exhibited the highest aroma score (16.13), followed by C_2 (15.79) and control C_1 (15.44). The interaction between rootstocks, varieties, and cane regulation significantly influenced the aroma evaluation. In pooled data, the treatment combination $R_2V_2C_3$ recorded the highest aroma score (20.05), followed by $R_2V_2C_2$ (19.73) and $R_2V_3C_3$ (19.15).

Organoleptic evaluation of taste

The taste evaluation in 2023, 2024, and in pooled data revealed significant differences due to rootstocks (Table 2). In pooled data, rootstock R_2 recorded significantly higher taste scores (19.54) compared to rootstock R1 (14.84). The variation in taste scores due to varieties was also significant. Variety V_2 had the highest taste score (18.35), followed by V3 (17.59) and V1 (17.22). The lowest taste score was recorded by variety V5 (16.07). Cane regulation had a non-significant effect on taste during 2023, 2024, and in pooled data. In pooled data, cane C_3 exhibited the highest taste score (17.48), followed by C_2 (17.16) and control C_1 (16.93). The interaction between rootstocks, varieties, and cane regulation significantly influenced the taste evaluation. In pooled data, the treatment combination $R_2V_2C_3$ recorded the highest taste score (21.47), followed by $R_2V_2C_2$ (20.54) and $R_2V_3C_3$ (20.04).

Table 1: Organoleptic evaluation for appearance and aroma.

Treatment	Appearance			Aroma		
	2023	2024	Pooled	2023	2024	Pooled
Root Stocks (R)						
R_1	13.51	12.38	12.94	14.10	12.74	13.42
R_2	18.59	17.22	17.90	19.19	17.13	18.16
S.E. M±	0.02	0.04	0.01	0.04	0.04	0.02
CD AT 5%	0.14	0.27	0.06	0.25	0.25	0.10
Varieties (V)						
V_1	16.41	14.69	15.55	17.11	14.99	16.05
V_2	18.06	16.89	17.47	18.13	16.48	17.31
V_3	17.12	15.80	16.46	17.44	15.82	16.63
V_4	15.29	14.16	14.72	16.22	14.48	15.35
V_5	13.36	12.47	12.91	14.32	12.92	13.62
S.E. M±	0.44	0.30	0.29	0.22	0.23	0.15
CD AT 5%	1.32	0.89	0.86	0.65	0.70	0.46
Canes (C)						
C_1	15.71	14.47	15.09	16.23	14.66	15.44
C_2	16.00	14.80	15.40	16.66	14.93	15.79
C_3	16.43	15.13	15.78	17.04	15.22	16.13
S.E. M±	0.26	0.24	0.19	0.29	0.28	0.21
CD AT 5%	0.73NS	0.69NS	0.55	0.82NS	0.8NS	0.59NS
Root Stocks (R) x Canes (C) x Varieties (V)						
$R_1V_1C_1$	13.84	11.89	12.86	14.51	12.66	13.59
$R_1V_1C_2$	13.96	12.52	13.24	14.70	12.68	13.69
$R_1V_1C_3$	14.10	13.02	13.56	14.80	12.90	13.85
$R_1V_2C_1$	14.96	13.89	14.43	15.03	13.97	14.50
$R_1V_2C_2$	15.06	14.52	14.79	15.59	14.29	14.94
$R_1V_2C_3$	15.55	14.62	15.09	15.79	14.45	15.12
$R_1V_3C_1$	14.46	13.38	13.92	14.82	13.60	14.21
$R_1V_3C_2$	14.59	13.63	14.11	14.91	13.69	14.30
$R_1V_3C_3$	14.86	13.82	14.34	14.93	13.78	14.36
$R_1V_4C_1$	12.67	11.59	12.13	13.50	11.98	12.74
$R_1V_4C_2$	12.89	11.64	12.27	13.58	12.57	13.07
$R_1V_4C_3$	13.59	11.81	12.70	13.89	12.59	13.24
$R_1V_5C_1$	10.37	9.11	9.74	10.38	10.10	10.24
$R_1V_5C_2$	10.76	9.55	10.16	11.76	10.72	11.24
$R_1V_5C_3$	10.93	10.72	10.82	13.32	11.16	12.24
$R_2V_1C_1$	18.33	16.71	17.52	19.27	17.11	18.19
$R_2V_1C_2$	18.91	16.97	17.94	19.61	17.27	18.44
$R_2V_1C_3$	19.29	17.01	18.15	19.77	17.33	18.55
$R_2V_2C_1$	20.18	19.22	19.70	20.55	18.44	19.50
$R_2V_2C_2$	20.94	19.36	20.15	20.70	18.76	19.73
$R_2V_2C_3$	21.66	19.70	20.68	21.13	18.97	20.05
$R_2V_3C_1$	19.44	17.44	18.44	19.91	17.75	18.83
$R_2V_3C_2$	19.52	17.94	18.73	19.95	17.93	18.94
$R_2V_3C_3$	19.87	18.59	19.23	20.12	18.18	19.15
$R_2V_4C_1$	17.20	16.55	16.87	18.44	16.41	17.43
$R_2V_4C_2$	17.22	16.66	16.94	18.70	16.61	17.65
$R_2V_4C_3$	18.17	16.68	17.43	19.18	16.70	17.94
$R_2V_5C_1$	15.65	14.93	15.29	15.88	14.55	15.22
$R_2V_5C_2$	16.19	15.23	15.71	17.09	14.79	15.94
$R_2V_5C_3$	16.25	15.29	15.77	17.47	16.18	16.83
S.E. M±	0.81	0.76	0.61	0.91	0.88	0.66
CD AT 5%	2.31	2.17	1.74	2.60	2.52	1.88

Table 2: Organoleptic evaluation for taste and colour.

Treatment	Taste			Colour		
	2023	2024	Pooled	2023	2024	Pooled
Root Stocks (R)						
R_1	15.49	14.19	14.84	16.30	15.11	15.70
R_2	20.52	18.56	19.54	21.16	19.64	20.40
S.E. M±	0.05	0.04	0.02	0.05	0.04	0.04
CD AT 5%	0.30	0.26	0.14	0.32	0.25	0.24
Varieties (V)						
V_1	17.88	16.55	17.22	18.57	17.23	17.90
V_2	19.20	17.50	18.35	20.10	19.18	19.64
V_3	18.31	16.88	17.59	19.48	17.69	18.59
V_4	17.51	15.92	16.72	18.01	16.78	17.39
V_5	17.11	15.04	16.07	17.48	16.02	16.75
S.E. M±	0.29	0.30	0.19	0.35	0.39	0.27
CD AT 5%	0.88	0.91	0.58	1.04	1.17	0.80
Canes (C)						
C_1	17.75	16.11	16.93	18.49	17.05	17.77
C_2	17.99	16.32	17.16	18.76	17.32	18.04
C_3	18.27	16.70	17.48	18.94	17.76	18.35
S.E. M±	0.28	0.27	0.20	0.30	0.25	0.21
CD AT 5%	0.8NS	0.78NS	0.57NS	0.84NS	0.72NS	0.6NS
Root Stocks (R) x Canes (C) x Varieties (V)						
$R_1V_1C_1$	15.10	14.30	14.70	16.00	14.70	15.35
$R_1V_1C_2$	15.29	14.33	14.81	16.20	14.76	15.48
$R_1V_1C_3$	15.56	14.38	14.97	16.67	14.76	15.72
$R_1V_2C_1$	16.28	14.68	15.48	17.14	16.64	16.89
$R_1V_2C_2$	16.49	14.99	15.74	17.55	16.99	17.27
$R_1V_2C_3$	17.15	16.20	16.68	17.86	17.68	17.77
$R_1V_3C_1$	15.62	14.38	15.00	16.77	14.87	15.82
$R_1V_3C_2$	16.10	14.41	15.26	16.78	15.40	16.09
$R_1V_3C_3$	16.18	14.67	15.42	16.90	15.77	16.33
$R_1V_4C_1$	14.81	13.86	14.34	15.78	14.42	15.10
$R_1V_4C_2$	14.97	13.92	14.45	15.84	14.54	15.19
$R_1V_4C_3$	15.07	14.10	14.58	15.87	14.67	15.27
$R_1V_5C_1$	14.38	12.51	13.45	14.47	13.03	13.75
$R_1V_5C_2$	14.48	13.00	13.74	15.12	14.07	14.60
$R_1V_5C_3$	14.80	13.19	14.00	15.51	14.34	14.93
$R_2V_1C_1$	20.30	18.32	19.31	20.48	19.66	20.07
$R_2V_1C_2$	20.50	18.93	19.72	20.98	19.71	20.34
$R_2V_1C_3$	20.55	19.06	19.80	21.10	19.77	20.44
$R_2V_2C_1$	21.06	19.33	20.20	22.29	20.65	21.47
$R_2V_2C_2$	21.64	19.43	20.54	22.85	20.99	21.92
$R_2V_2C_3$	22.56	20.38	21.47	22.95	22.09	22.52
$R_2V_3C_1$	20.56	19.24	19.90	22.09	19.81	20.95
$R_2V_3C_2$	20.64	19.24	19.94	22.12	19.82	20.97
$R_2V_3C_3$	20.76	19.32	20.04	22.23	20.46	21.35
$R_2V_4C_1$	19.95	17.68	18.81	20.13	18.85	19.49
$R_2V_4C_2$	20.09	17.82	18.96	20.17	18.96	19.56
$R_2V_4C_3$	20.20	18.12	19.16	20.28	19.22	19.75
$R_2V_5C_1$	19.45	16.79	18.12	19.72	17.88	18.80
$R_2V_5C_2$	19.72	17.16	18.44	19.99	17.95	18.97
$R_2V_5C_3$	19.82	17.58	18.70	20.06	18.84	19.45
S.E. M±	0.89	0.86	0.63	0.93	0.79	0.66
CD AT 5%	2.54	2.47	1.81	2.67	2.27	1.88

Table 3: Overall organoleptic evaluation

Treatment	Overall organoleptic evaluation		
	2023	**2024**	**Pooled**
Root Stocks (R)			
R_1	15.77	14.11	14.94
R_2	20.41	18.87	19.64
S.E. M±	0.04	0.02	0.01
CD AT 5%	0.22	0.13	0.06
Varieties (V)			
V_1	18.11	16.36	17.23
V_2	19.58	17.60	18.59
V_3	18.50	16.99	17.75
V_4	17.47	15.99	16.73
V_5	16.79	15.51	16.15
S.E. M±	0.28	0.27	0.22
CD AT 5%	0.84	0.81	0.65
Canes (C)			
C_1	17.86	16.33	17.10
C_2	18.06	16.50	17.28
C_3	18.35	16.64	17.50
S.E. M±	0.25	0.28	0.21
CD AT 5%	0.71NS	0.81NS	0.6NS
Root Stocks (R) x Canes (C) x Varieties (V)			
$R_1V_1C_1$	15.60	13.88	14.74
$R_1V_1C_2$	15.80	13.91	14.85
$R_1V_1C_3$	16.03	14.16	15.10
$R_1V_2C_1$	16.80	15.21	16.00
$R_1V_2C_2$	16.86	15.35	16.10
$R_1V_2C_3$	17.27	15.40	16.34
$R_1V_3C_1$	16.08	14.62	15.35
$R_1V_3C_2$	16.13	14.68	15.41
$R_1V_3C_3$	16.57	14.73	15.65
$R_1V_4C_1$	14.88	13.45	14.16
$R_1V_4C_2$	15.32	13.68	14.50
$R_1V_4C_3$	15.39	13.75	14.57
$R_1V_5C_1$	14.40	12.60	13.50
$R_1V_5C_2$	14.73	13.08	13.91
$R_1V_5C_3$	14.75	13.09	13.92
$R_2V_1C_1$	20.23	18.65	19.44
$R_2V_1C_2$	20.46	18.70	19.58
$R_2V_1C_3$	20.53	18.86	19.69
$R_2V_2C_1$	22.02	19.53	20.78
$R_2V_2C_2$	22.18	19.76	20.97
$R_2V_2C_3$	22.35	20.34	21.34
$R_2V_3C_1$	20.54	19.14	19.84
$R_2V_3C_2$	20.58	19.35	19.96
$R_2V_3C_3$	21.12	19.42	20.27
$R_2V_4C_1$	19.53	18.31	18.92
$R_2V_4C_2$	19.74	18.35	19.04
$R_2V_4C_3$	19.97	18.38	19.18
$R_2V_5C_1$	18.57	17.91	18.24
$R_2V_5C_2$	18.78	18.10	18.44
$R_2V_5C_3$	19.50	18.30	18.90
S.E. M±	0.79	0.89	0.66
CD AT 5%	2.25	2.55	1.89

Organoleptic evaluation of colour

The colour evaluation in 2023, 2024, and pooled data revealed significant differences due to rootstocks (Table 2). In pooled data, rootstock R_2 recorded significantly higher colour scores (20.40) compared to rootstock R_1 (15.70). The variation in colour scores due to varieties was also significant. Variety V_2 had the highest colour score (19.64), followed by V_3 (18.59) and V_1 (17.90). The lowest colour score was recorded by variety V_5 (16.75). Cane regulation had a non-significant effect on colour during 2023, 2024, and in pooled data. In pooled data, cane C_3 exhibited the highest colour score (18.35), followed by C_2 (18.04) and control C_1 (17.77). The interaction between rootstocks, varieties, and cane regulation significantly influenced the colour evaluation. In pooled data, the treatment combination $R_2V_2C_3$ recorded the highest colour score (22.52), followed by $R_2V_2C_2$ (21.92) and $R_2V_3C_3$ (21.35).

Overall organoleptic evaluation

The overall organoleptic evaluation in 2023, 2024, and pooled data revealed significant differences influenced by rootstocks (Table 3). In pooled data, rootstock R_2 had a higher overall evaluation score (19.64) compared to R_1 (14.94), showing a notable difference in the quality of the treatments. For varieties, V_2 scored the highest in pooled data (18.59), followed by V_3 (17.75) and V_1 (17.23), with V_5 showing the lowest score (16.15). The effect of cane regulation on the overall evaluation was non-significant across all years and pooled data, as canes C_1, C_2, and C_3 displayed similar scores. In pooled data, C_3 had the highest score (17.50), followed by C_2 (17.28) and C_1 (17.10). The interaction between rootstocks, varieties, and cane regulation significantly affected the overall evaluation. In pooled data, the highest scores were observed in the combinations of $R_2V_2C_3$ (21.34), $R_2V_2C_2$ (20.97), and $R_2V_2C_1$ (20.78), with the lowest scores coming from combinations involving R_1, such as $R_1V_5C_1$ (13.50) and $R_1V_4C_1$ (14.16).

The pooled data demonstrated significant differences in organoleptic evaluations across rootstocks, varieties, and their interactions, showcasing their influence on grape quality parameters such as appearance, aroma, taste, and colour. Rootstock R_2 consistently outperformed R_1 in all parameters, ascribing its superior performance to enhanced nutrient uptake and better compatibility with scion varieties, corroborating findings by Tarricone *et al* (2023) who reported improved berry appearance and sensory quality in grapes grafted onto vigorous rootstocks. Similarly, the significant variation among varieties highlights the influence of genetic factors, with variety V_2 excelling in appearance, aroma, taste, and colour. These results align with the studies of Singh *et al* (2022), where *Vitis vinifera* cultivars exhibited varietal differences in sensory traits due to variations in biochemical composition. The non-significant effects of cane regulation on aroma, taste, colour, and overall evaluation suggest that cane numbers alone may not have a direct influence on organoleptic properties. However, the superior scores observed in treatments involving C_3 could be attributed to its optimized canopy structure, leading to better light interception and photosynthetic efficiency, as discussed by Mian *et al* (2024). The interaction effects revealed that the highest scores in all organoleptic parameters were recorded for the $R_2V_2C_3$ combination, emphasizing the synergistic impact of selecting suitable rootstock-variety combinations alongside appropriate cane regulation. This finding aligns with reports by Blank *et al* (2022), who demonstrated that rootstock-scion interactions coupled with optimal cultural practices could significantly enhance grape quality.

CONCLUSION

The study highlighted the critical role of rootstocks and varietal characteristics in enhancing the organoleptic qualities of grapes, with R_2 and V_2 emerging as the most promising treatments. Additionally, while cane regulation had a limited direct impact, its interaction with rootstock and variety contributed significantly to the overall quality. These findings underline the importance of adopting an integrated approach combining rootstock selection, variety choice, and cultural practices to optimize grape production and sensory quality in the northern dry zone of Karnataka.

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