SKUAST Journal of Research 26(3): 433-438; (2024)
(*DOI No. 10.5958/2349-297X.2024.00044.7*); NASS rating: 4.88

Research Paper

Effectiveness of colour improving sprays on physical characteristics of apple (*Malus x domestica* Borkh) cv. Ambri

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(Received May 20, 2023; accepted July 21, 2023)

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ABSTRACT

The present investigation entitled "Effectiveness of colour improving sprays on physical characteristics of apple(*Malus x domestica* Borkh) cv. Ambri"was carried out at Experimental field of Ambri Apple Research Centre (AARC), Shopian, SKUAST-Kashmir, during the year 2022-2023. Eight treatments, viz; control (water spray), potassium sulphate (5 g per litre of water), phenylalanine (@ 0.1,0.2 and 0.3%), nano-potash (@ 1, 2 and 3ml/l of water) were selected for colour improvement. The treatments were applied 30 days prior to harvest. The experiment was laid in complete randomised block design with 3 replications having 3 trees per replication. The results showed that all the treatments outperformed control in terms of physical characteristics.The treatment T_4 (Phenylalanine @ 0.3%) significantly excelled in all the treatments applied. Significantly higher fruit colour (35.25 a*), fruit firmness (8.05 kg/cm^2), fruit weight (196.39 g), fruit length (7.52 cm), fruit diameter (7.31 cm), fruit volume (191.15 cm^3) and organoleptic rating (3.84 /4.00 pts) was recorded in T_4(Phenylalanine @ 0.3%) as compared to other treatments.According to the current study, apple cultivar Ambri responded favourably to the application of foliar phenylalanine in improving fruit colour, which otherwise lacks in this cultivar and also improved the other physical characteristics.The application of Phe @ 0.3% at 30 days prior to harvest proved superior in enhancing the quality features, notably the red coloration of apple cv. Ambri.

Key words: Nano-potash, phenylalanine, potassium sulphate

Apple (*Malus* × *domestica* Borkh.) is a typical temperate fruit belonging to family Rosaceae and sub family Pomoideae. The cultivated apple is a functional diploid (2n=34) (Ryugo, 1988), although the triploids are present in the genus (Pereira-Lorenzo *et al.*, 2007). The tree originated in Central Asia where its wild ancestor, *Malus sylvestris*, still exists. The total area under cultivation of apple in India is 3.13 lakh hectares with a production of 2.3 million, MT (FAO, 2022). Apple can be grown at an altitude of 1500-2700 m amsl in the Himalayan range which experience 1000-1500 hours of annual chilling. Jammu and Kashmir is the largest producer of apple in India with an area of about 1.65 lakh hectares and production of 20 lakh MT (Anonymous,2020) contributing more than 70 percent of the total apple production in India.

Fig 1: At harvest time (AARC, Phanoo Shopian)

Fig 2: T_0 (Control)

Fig 3:T_4 (Phe @ 0.3%)

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Ambri apple is the only apple that originates in India and is considered as autochthonous to Kashmir. Ambri apple is appealing with a high keeping quality and is chosen for its sweet taste, crispness and fragrance.It is widely famous for its crispiness, aroma, flavor and attractiveness. In addition, they have a unique taste, aroma and flavour and an excellent texture (Devi *et al.*, 2021). But poor skin colour is a significant problem for the marketing of Ambri apples. Apple peel colour determines apple market acceptance and colour branding has been incorporated into the grading standards of many varieties of apples. In general, well- colored bright red types of apples are preferred by consumers who buy on impulse and associate peel colour with level of fruit ripeness. Cyanidin-3-galactoside (Idaein) is the main pigment responsible for the red color in apple, which belongs to the anthocyanin group (Saure, 1990). It is well known that the red pigment formation process depends mainly on environmental factors such as temperature, light quality and light interception. Cultural practices such as pruning, thinning, fertilization (potassium) and plant growth regulators like Phenylalanine influence red colour formation.Based on the above propositions, our study entitled "Effectiveness of colour improving sprays on physical characteristics of apple (*Malus x domestica* Borkh) cv.Ambri'' was undertaken at, Ambri Apple Research Centre (AARC) Phanoo, Shopian during the year 2022 with objectives of improving fruit colour of cv. Ambri using various chemicals and thereby increasing its consumer acceptability. Also the effect of these chemical sprays was assessed on various physical characteristics of Ambri apple.

MATERIALS AND METHODS

The current study entitled "Effectiveness of colour improving sprays on physical characteristics of apple (*Malus x domestica* Borkh) cv Ambri" was undertaken at Experimental Fields of Ambri Apple Reseach centre (AARC) Phanoo, SKUAST-Kashmir, Shopian" which is situated at an altitude of 1594 m amsl between 33.747°N, 74.855°E during the years 2021-2022. The trees selected for the present study were ofuniform age (15 ± 2) and vigour, grafted on MM106 rootstock and planted at a distance of 2.5 × 3 m.Eight different chemical treatments were selected which included:T_0:control (water spray), T_1: Potassium sulphate @ 5 g/L, T_2: Phenylalanine @ 0.1, T_3: Phenylalanine@ 0.2%,T_4: Phenylalanine@ 0.3%), T_5: Nano-potash (@ 1 ml/L, T_6: Nano-potash (@ 2 ml/L and T_7: Nano-potash (@ 3 ml/L were selected for colour improvement. The treatments were applied 30 days prior to harvest.The experimental design was RCBD with three replications in each treatment.The fruit of each treatment were harvested at optimum maturity and were analyzed for different parameters.The fruit weight was measured by pan balance and average weight was expressed in grams (g).The length and diameter of fruits was measured with the help of digital vernier calliper (12 x 300 mm).The Effegi model penetrometer was used to measure the firmness of the fruit. Apple colour was measured using the Hunter lab colorimeter. Fruit chromaticity was recorded in Commission Internationale d'Eclairage (CIE) parameters *L**, *a** and *b** colour space coordinates. The experimental data was then subjected to statistical analysis as per the standard statistical procedure given by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The data pertaining to (Table.1) shows that the application of potassium sulphate, phenylalanine and Nano-Potash spray at different concentrations had a profound influence on fruit size. Maximum fruit length(7.52 cm), fruit diameter (7.31 cm) and volume (191.15 cm^3) was found in treatment T_4 (Phe @ 0.3%), followed by

treatment T_3 (Phe@ 0.2%) in which fruit length, fruit diameter and fruit volume of 7.38 cm, 7.25 cm and 189.05 cm^3 was observed respectively. Minimum fruit length, fruit diameter and volume of 6.93 cm, 6.50 cm and 184.10 cm^3 respectively was found in treatment T_0 (control).Increase in fruit size (length, diameter and volume) was attributed to the fact that phenylalanine and K^+ ions are responsible for cell division and cell expansion which eventually contribute towards controlling the growth (Marschner, 2012). It is known that phenylalanine influence cell-expansion in the longitudinal direction (El-Abd, 2011). The positive effect of potassium on fruit size can be ascribed to the fact that potassium helps in the translocation of newly synthesized photosynthates and also helps in mobilization of stored material. Potassium also activates enzymes, involved to the energy transfer, build-up of ATP (energy-rich bonds) needed for CO_2 assimilation and the synthesis of sugar, starch and protein (Mostafa *et al*., 2000).

Table 1: Effect of different chemical sprays on fruit weight (g), fruit length (cm) and fruit diameter (cm) of Apple cv. Ambri

Treatment	Fruit length (cm)	Fruit diameter (cm)	Fruit volume (cm^3)
T_0 (Control)	6.93	6.50	184.10
T_1 (K_2SO_4 @5g/l)	7.11	7.03	185.17
T_2 (Phenylalanine @ 0.1 %)	7.31	7.17	187.51
T_3 (Phenylalanine @ 0.2 %)	7.38	7.25	189.05
T_4 (Phenylalanine @ 0.3 %)	7.52	7.31	191.15
T_5 (Nano-Potash @ 1ml/l)	6.94	6.49	184.16
T_6 (Nano-Potash @ 2ml/l)	6.96	6.55	184.28
T_7 (Nano-Potash @ 3ml/l)	6.99	6.59	184.69
SE(d)	**0.021**	**0.018**	**0.865**
CD (p≤ 0.05)	**0.046**	**0.039**	**1.731**

Examination of data presented in Table 2 reveals that application of potassium sulphate, phenylalanine and Nano-Potash at different concentrations has a profound influence on fruit weight. The maximum fruit weight (196.39 g) was noted in case of the treatment T_4 (Phe @ 0.3%).The treatment T_3 (Phe @ 0.2%) was statistically at par with T_2 (Phe @ 0.1%) having a fruit weight of 195.24 and 194.12 g and treatment T_2 (Phe @ 0.1%) was statistically at par with treatment T_1 (K_2SO_4 @ 5g/l) having a fruit weight of 194.12 and 193.68 g respectively. Minimum fruit weight (190.88 g) was observed in case of treatment T_0 (control). As seen from the data T_0 (control) is comparable to T_5 and T_6 indicating little impact of nano potash on fruit weight. Similar results for nano potash were observed by Frank and Husted (2023). Foliar spray of phenylalanine resulted in a significant increase in the photosynthesis process, which leads to an increase in production of carbohydrates as well as increase efficiency of the plant in absorption Kotb *et al.* (2018). The increase in weight of fruit may be due to the increased photosynthetic activities. Leaves supply photosynthates to fruits which act as metabolic sink and potassium is considered for increase in this activity (Hansen, 1970). The observations confirm the findings of Solhjoo *et al.* (2017) who reported that foliar potassium increases fruit weight of apple.

As evident from the Table 2, that application of potassium sulphate, phenylalanine and Nano-Potash sprays at different concentrations had a pronounced influence towards fruit firmness. In this context, maximum fruit firmness of (8.05 kg/cm^2) was observed in T_4 (Phe@ 0.3%) which was followed by T_3 (Phe@ 0.2 %) and T_2 (Phe @ 0.1%), whereas the least fruit firmness (6.51 kg/cm^2) was observed in control (T_0). The fact that T_0 (control) is significantly at par with T_5 indicating nanopotash has not influenced fruit firmness. Similar results were observed by Frank and Husted, 2023.The present findings revealed that the increase in fruit firmness as a result of phenylalanine treatments may be due to maintaining the plasma membrane integrity and mitigated the effect of ethylene on the cell wall or membranes lipid degradation (Kotb *et al*, 2018). On the other hand, the decrease in firmness due to potassium application can be due to the fact that Ca content of fruits sharply decreased with increased K application, since calcium is an essential component of the cell wall, thus low concentration of Ca^{2+} will definitely have an effect on cell wall formation, hence directly effecting fruit firmness (Anjum *et al.*, 2008). Similar results and findings were observed by (Fallahi *et al*., 2010) whose study reported

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that potassium fertigation decreased firmness at harvest probably due to increase of K/Ca ratio in fruit.

Table 2: Effect of different chemical sprays on fruit volume (cm^3), fruit firmness (kg/ cm^2) and fruit organoleptic rating of Apple cv. Ambri

Treatment	Fruit weight (g)	Fruit firmness (kg/cm^2)	Fruit organoleptic rating (pts)
T_0 (Control)	190.88	6.51	2.50
T_1 (K_2SO_4 @5g/l)	193.68	6.74	3.32
T_2 (Phenylalanine @ 0.1 %)	194.12	7.23	3.54
T_3 (Phenylalanine @ 0.2 %)	195.24	7.59	3.74
T_4 (Phenylalanine @ 0.3 %)	196.39	8.05	3.84
T_5 (Nano-Potash @ 1ml/l)	191.23	6.55	2.50
T_6 (Nano-Potash @ 2ml/l)	191.25	6.62	2.52
T_7 (Nano-Potash @ 3ml/l)	191.75	6.65	2.55
SE(d)	**0.326**	**0.029**	**0.020**
CD (p≤ 0.05)	**0.653**	**0.063**	**0.042**

Perusal of data presented in Table 2 reveals that application of potassium sulphate, phenylalanine and Nano-Potash spray at different concentrationshad pronounced influence on organoleptic ratingof fruit. Highest organoleptic rating (3.84) was observed in T_4 (Phe@ 0.3%) followed by T_3 (Phe@ 0.2%) and T_2 (Phe@ 0.1%). The minimum organoleptic rating (2.50) was found in treatmentcontrol (T_0). This may be attributed to the fact that these sprays lead to considerable increase in total soluble solids & sugars content which in turn resulted in high organoleptic rating of the fruit (Kotb *et al*, 2018). These results are in harmony with (Yadav *et al*., 2014) in ber and (Mosa *et al*.,2015) in Anna apple.

Data presented in Table 3 gives a vivid clarity that application of potassiumsulphate, phenylalanine and Nano-Potashspray at different concentrations had a great influence on fruit colour. Highest *L** (lightness) value (54.83) was observed in treatment T_0 (control) whileas, lowest L* value (37.76) was observed in treatment T_4 (Phe @ 0.3%). Data presented also reveals that red colour of fruit was significantly different among different treatments. The highest *a** (30.25), lowest b^* value (16.21) was observed in T_4 (Phe @ 0.3%).

Table 3. Effect of different chemical sprays on fruit colour L* a*, b*of Ambri apple

Treatment	Lightness (L*)	Red colour (a*)	Yellow colour (b*)
T_0 (Control)	54.83	17.05	24.43
T_1 (K_2SO_4 @5g/l)	42.81	21.86	19.18
T_2 (Phenylalanine @ 0.1 %)	40.97	25.44	18.75
T_3 (Phenylalanine @ 0.2 %)	38.86	29.21	16.64
T_4 (Phenylalanine @ 0.3 %)	37.76	30.25	16.21
T_5 (Nano-Potash @ 1ml/l)	43.96	17.54	24.39
T_6 (Nano-Potash @ 2ml/l)	42.60	17.65	24.37
T_7 (Nano-Potash @ 3ml/l)	42.16	17.86	24.26
SE(d)	**0.475**	**0.603**	**0.500**
CD (p≤ 0.05)	**1.028**	**1.306**	**1.082**

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While the lowest *a** value (17.05), highest *b** value (24.43) was noted in case of treatment T_0 (control). The reason for the increase in color is phenylalanine, an aromatic amino acid that occurs naturally and is obtained from the shikimate pathway. It is the starting point for the phenylpropanoid biosynthesis pathway, which produces an accumulation of red color in fruit peels. One of the secondary metabolites of this pathway is anthocyanins (Fanyuk *et al*, 2022). These results were found to be more in harmony with those obtained by (Muengkaew*et al*. 2016) in mango and (Ommol *et al*., 2020) in plum. Role of potassium towards increasing the fruit colour may be due to the function of potassium that plays an indispensable role towards metabolic and physiological process of plant, by influencing the enzymatic activities, which were enhanced due to the variations in potassium levels, thus resulting in increased CO_2 assimilation and subsequent increase in carbohydrate and anthocyanin synthesis (Banday, 2015).

CONCLUSION

The efficacy of three different chemicals (potassium sulphate, phenylalanine and nano-potash) on fruit colour, fruit size (length, diameter, volume), fruit weight, fruit firmness and fruit organoleptic rating were investigated.Phenylalanine and Potassium sulphate treatments resulted in improvement of fruit quality including fruit colour. It was concluded that foliar application of phenylalanine @ 0.3%, 4 weeks before harvest is very much effective in overcoming colour development problems in Ambri besides helps in higher quality fruit.

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REFERENCES

Anjum, R., Kirmani, N. A., Nageena, N. and Sameera, S. 2008. Quality of apple Cv. Red Delicious as influenced by potassium. *Asian Journal of Soil Science,* **3**: 227-229.

Anonymous, 2020. District wise area and production of major horticultural crops of Jammu and Kashmir State. Department of Horticulture, Jammu and Kashmir.

Banday, S. A. 2015. Effect of soil and foliar application of nitrogen and potassium on yield, quality and nutrient status of apple cv. Red Delicious. Ph. D. Dissertation, Sher-e-Kashmir University of Agricultural Sciences Technology of Kashmir, India.

Devi, K., Kour, K., Bakshi, P., Sharma, B.C., Sharma, M., and Sinha, B.K.2021.Assessment of Morphological Diversity in indigenous Ambri apple (Malus x domestica Borkh.). *Biological Forum,* **3**: 325-331.

El-Abd, M. A. 2011. Enhancement of "Florida prince" peach fruit quality under prince fruit quality under protected cultivation by using natural compounds. Ph. D Faculty of Agriculture, Damanhour University, Egypt.

Fallahi, E., Fallahi, B., Neilsen, G. H., Neilsen, D. and Peryea, F. J. 2010. Effects of mineral nutrition on fruit quality and nutritional disorders in apples. *Acta Horticulturae* **68**: 49-60.

Fanyuk, M., Patel, M. K., Ovadia, R., Maurer, D., Feygenberg, O., Oren-Shamir, M. and Alkan, N., 2022. Preharvest applications of phenylalanine induces Red color in Mango and Apple fruit's skin. *Antioxidants***11:** 491.

FAO, 2022. World Area and Production. Food and Agriculture Organization of the United Nations Statistics division (FAOSTAT). http: //www. fao. Org.

Frank, M., and Husted, S. 2023. Is India's largest fertilizer manufacturer misleading farmers and society using dubious plant and soil science? *Plant Soil*/10.1007/s11104-023-06191-4

Gomez, K. A. and Gomez, A. A.1984. Statistical Procedures for Agricultural Research (2th edition). Hohn Willey and Sons, New York, USA pp. 28-92.

Hansen, P. 1970. The effect of N, K, Ca and Mg on the nutrient growth and leaf development of Cox's Orange apples in sand culture. *Tidsskr Planteavl,* **74**: 557-585.

Kotb, H. R. M., El-Abd, M. A. M. and Abd El-Gawad, M. G. 2018. Effect of spraying some natural compounds on quality and marketing of "Anna" apple fruits. *Asian Journal of Advances in Agricultural Research,* **23** 608: 635.

Marschner, P. 2012. Mineral nutrition of higher plants, 3rd ed., 651 p. Academic Pres, London, UK.

Mosa, W. F. A., EL-Megeed, N. A. and Paszt, L. S. 2015. The effect of the foliar application of potassium, calcium, boron and humic Acid on vegetative growth, fruit set, leaf mineral, yield and fruit quality of 'Anna' apple trees. *American Journal of Experimental Agriculture,* **8**: 224-234.

Mostafa, M. F., El-Boray, M. S., Iraqi, M. A. and EL-Bary, A. A. 2000. Effect of potassium and boron application on yield, fruit quality and leaf mineral content of Anna apple trees. *Journal of Agricultural Science Mansoura Univ.,* **24**: 4965-4977.

Muengkaew, R., Chaiprasart, P. and Warrington, I., 2016. Changing of physiochemical properties and color development of mango fruit sprayed methyl Jasmonate. *Scientia Horticulturae***198**: 70-77.

Ommol, B. S., Vali, R., Farhang, R. and Gholamreza, G. 2020. Phenylalanine Alleviates Postharvest Chilling Injury of Plum Fruit by Modulating Antioxidant the Accumulation of Phenolic Compounds. *Food Technol Biotechnol,* **58**: 433-444.

Pereira-Lorenzo, S., Ramos-Cabrer, A. M. and Diaz-Herna'ndez, M. B. 2007. Evaluation of genetic identity and variation of local apple cultivars (*Malus x domestica*) from spainusing microsatellite markers. *Genetic Resource Crop Evolution,* **54**: 405-420.

Ryugo, K. 1988. Fruit Culture. John Wiley and Sons, New York pp. 344.

Saure, M. C. 1990. External control of anthocyanin formation in apple. *Scientia Horticulturae,***42**: 181-218.

Solhjoo, S., Gheraghani, A. and Fallahi, E. 2017. Calcium and potassium foliar sprays affect fruit skin colour, quality attributes and mineral nutrient concentrations of Red Delicious apples. *International Journal of Fruit Science ,***17**: 358-373.

Yadav, D., Singh, S. P. and Singh, S. 2014. Effect of foliar application of potassium compounds on yield and quality of ber (*Zizyphus mauritiana* Lam.) cv. Banarasi Karaka. *International Journal of Research in Applied, Natural and Social Sciences,* **2**: 89-92.

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