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Effect of Girdling on Bio-chemicals Parameters in Plum cv. Kala Amritsari

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***Abstract*: E**xperiment was with the objective to improve the fruit quality through girdling in sub-tropical (low chilling requiring) plum cv. Kala Amritsari during 2022 and 2023 at CCS HAU, Hisar. The experiment encompasses of five treatments *viz*. girdling at full bloom stage (more than 70 % flower anthesis), girdling after fruit set (14 days after petal fall), girdling at pit hardening stage, girdling at 15 days before harvesting and control (un girdled). Among various girdling treatments, girdling at pit hardening stage significantly increased fruits bio-chemical quality (total soluble solids, sugars, anthocyanin content) and decreased acidity, carotenoid content followed by girdling after fruit set over the other remaining girdling treatments. The girdling at full bloom stage was inferior to control (un girdled) in all parameters studied except carotenoid content parameter. Ascorbic acid parameter was non-significant with girdling treatments.

Keywords: Plum, Anthocyanin, Carotenoids, Quality, Bio-chemicals.

Plum is a delicious stone fruit of temperate regions. In Europe, its importance is next to apple. In India, it is grown in hilly tracts of north- eastern states, Jammu and Kashmir, Himachal Pradesh, Punjab, Haryana, Uttarakhand and parts of Uttar Pradesh. Some low chilling and early ripening cultivars can also be grown in sub-tropical regions. At national level it has covered an area of 17930 ha with production of 69530 MT (Anonymous 2023a) but, in Haryana it was grown on 66.2 ha with production of 1314.71 MT (Anonymous 2023b). The growth and fruitfulness of a plant is greatly influenced by the relative proportions of carbohydrates and nitrogen. The C:N ratio of crop plants can be altered through simple special horticultural practices like girdling. It is basically an intervention in the phloem transport between canopy and roots, an attempt to manipulate the distribution of photosynthate, mineral nutrients and plant bioregulators. Wide variety of fruit species are girdled to induce flowering, improve fruit set, increase in yield, enlarge fruit size, advance maturity and improve quality. This methodology is extremely effective controlling vegetative growth, enhancement of fruit yield and quality attributes in horticultural crops. Hence, considering the above importance and keeping in view the potential of girdling for quality improvement the present investigation effect of girdling on bio-chemicals parameters in plum cv. Kala Amritsari was planned with objectives to systematize the time of girdling for quality enhancement in plum.

MATERIAL AND METHODS

Experimental site and climate: The present study was carried out at experimental orchard, Department of Horticulture, CCS HAU, Hisar, Haryana, situated at an altitude of 215.2 m above mean sea level with coordinates of 29°15' North and 75°68' East of Haryana. Hisar has typically semi-arid with very hot dry summers and excessively winter weather condition. The climate is characterized by dryness, high temperature and light rainfall. Temperature reaches around 45^{0}C accompanied by hot and dry winds in May-June, however, sometimes the temperature drops to freezing point followed by occasional frost in December-January. Hisar receives 80-85 per cent of total rainfall *i.e.* 450 mm during July to September and 10-15 per cent during winter month *i.e.*, December to February which is due to western disturbances.

Treatment details: The field experiment was conducted on 15 years old plum cv. Kala Amritsari with spacing 6m×6m. Twenty uniformly grown plants having similar growth were selected which were under uniform agronomic practices as per recommended (Anonymous 2021). All plants were maintained under uniform practices of orchard management during the study period. The experiment was laid out in randomized block design with three replications by taking one tree per replication and girdling was done with girdling knife of 2 mm width four stages at full bloom stage (more than 70 % flower anthesis), after fruit set (14 days after petal fall); at pit hardening stage; at 15 days before harvesting and control (no girdling).

RESULTS AND DISCUSSION

Quality attributes: TSS (^{0}Brix): The maximum total soluble

solids 15.22 ^{0}Brix and total sugars 12.13 per cent (Table 1); reducing sugars 6.79 per cent and non-reducing sugars 5.35 per cent was observed in girdling at pit hardening stage (T_4) followed by treatment girdling after fruit set (T_3) and minimum were in girdling at full bloom (T_2) (Table 2). The improvement in fruit quality in terms of TSS and sugars might be due to the accumulation of more assimilates above the girdle at pit hardening stage and their translocation to the parts above it with a reduction in supply of basipetal mobile factors to the root system. Kaur et al. (2019) observed in peach that treatment of urea @ 0.2 per cent with branch girdling had maximum TSS, sugars. Similarly, El-Kenawy et al. (2018) in grape vines noticed that jasmonic acid 40 ppm+ girdling gave the highest significantly values in SSC and total sugars.

Acidity (%): Different girdling treatments such as girdling at full bloom and control showed higher value of acidity than treatments girdling after fruit set, girdling at pit hardening stage and girdling 15 days before harvesting. The maximum acidity of 1.64 per cent was in girdling at full bloom (T_2) and minimum in girdling at pit hardening stage (T_4) followed by girdling after fruit set (T_3). Reduction in acidity in T_4 and T_5 might be due to conversion of organic acids into sugar and dilution effect as a result of increased fruit size or might be due to increase in total soluble solids at the expense of acid content. The acids under the influence of nutrients might get converted into sugars and their derivative by the reaction involving the reversal of glycolytic pathway. These results was supported by Azizi et al. (2022) in Kiwi vines where highest TSS, total sugar, reducing sugar, non-reducing sugar and lowest in acidity in f girdling in grafted vines. Similarly, Kaur et al. (2019) observed in peach that urea @ 0.2 per cent with branch girdling had maximum TSS, sugars and lowest in acidity. El-Kenawy et al. (2018) in grape vines observed that jasmonic acid 40 ppm+ girdling recorded significantly higher SSC, total sugar and lowest acidity.

Ascorbic acid (mg/100 g pulp): There was non-significant effect of girdling on ascorbic acid. But, the girdling treatments such as girdling after fruit set, girdling at pit hardening stage and girdling 15 days before harvesting showed higher ascorbic acid than control. However, the maximum numeric

Observations

Parameters	Method suggested by
TSS, Acidity, Ascorbic Acid	A O A C (Association of Official Analytical Chemists - 1990)
Total, Reducing and Non-reducing sugars	Hulme and Narain (1993)
Anthocyanin content	Harborne (1973)
Carotenoid content	Hiscox and Isrealstam (1979); calculated as per the formulae given by Venkatarayappa et al. (1984)

Table 1. Effect of girdling on TSS (ºBrix) and total sugars (%) in plum cv. Kala Amritsari

Treatments	TSS (ºBrix)			Total sugars (%)		
	2022	2023	Pooled	2022	2023	Pooled
Control-T_1	14.67	14.3	14.49	11.74	11.36	11.55
Girdling at full bloom- T_2	13.97	13.5	13.74	11.18	10.8	10.99
Girdling after fruit set- T_3	15	14.9	14.95	12.11	11.92	12.02
Girdling at pit hardening stage- T_4	15.3	15.13	15.22	12.16	12.1	12.13
Girdling 15 days before harvesting- T_5	14.92	14.63	14.78	11.93	11.7	11.82
CD (p=0.05)	0.32	0.35	0.34	0.35	0.41	0.38

Table 2. Effect of girdling on reducing sugars (%) and non-reducing sugars (%) in plum cv. Kala Amritsari

Treatments	Reducing sugars (%)			Non-reducing sugars (%)		
	2022	2023	Pooled	2022	2023	Pooled
Control-T_1	6.57	6.36	6.47	5.17	5	5.09
Girdling at full bloom- T_2	6.26	6.04	6.15	4.92	4.76	4.84
Girdling after fruit set- T_3	6.77	6.67	6.72	5.34	5.25	5.30
Girdling at pit hardening stage- T_4	6.8	6.77	6.79	5.36	5.33	5.35
Girdling 15 days before harvesting- T_5	6.68	6.55	6.62	5.25	5.15	5.20
CD (p=0.05)	0.18	0.24	0.21	0.15	0.13	0.14

values of ascorbic acid 4.38 mg/100 g pulp (Table 3) was observed in treatment girdling at pit hardening stage (T_4) and minimum in girdling at full bloom (T_2). The improvement in fruit quality in terms of ascorbic acid might not be due to the lower rate of conversion of dehydro- ascorbic acid to ascorbic acid. The data presented was contrast to the findings of Azizi et al. (2022) in Kiwi vines where highest ascorbic acid was girdling at 1/4 girdled grafted vines whereas, Kaur *et al*. (2019) observed maximum ascorbic acid with branch girdling with combination of 0.2 per cent urea in peach cv. Shan-i - Punjab.

Anthocyanin content (mg/100 g pulp wt.): The girdling after fruit set, girdling at pit hardening stage and girdling 15 days before harvesting showed higher anthocyanin content than control. The maximum pulp anthocyanin content of 6.04 mg/100 g pulp wt. was observed in girdling at pit hardening stage (T_4) followed by girdling after fruit set (T_3) and minimum was observed in t girdling at full bloom (T_2). The improvement in fruit quality in terms of anthocyanin content might be due to girdling treatment influenced the pigment composition in both fruit pulp and skin, mainly promoting the biosynthesis of anthocyanin content that were increased linearly with the girdling duration in both fruit pulp and skin. In particular, the red colouration increased in the pulp. In plum fruit, the increase in reddish colouration can be ascribed to the increased biosynthesis of red/purple pigments (anthocyanin) and/or the degradation of other coloured molecules such as chlorophylls and carotenoids (Olivares et al., 2017) . Solfanelli et al. (2006) in Arabidopsis found that at the molecular level, anthocyanins can be induced by sugar accumulation in fruit pulp under girdling conditions likely induced the anthocyanin content biosynthesis making the pulp more reddish than that of control. Further, the anthocyanin increase induced by girdling was reported in some fruits, e.g. in grapes (Basile et al. 2018), red kiwifruit (Nardozza et al. 2018), cherries (Michailidis et al. 2020) and red plum (Piccolo et al. 2021).

Carotenoid content (mg/100g pulp wt.): The girdling treatments such as girdling after fruit set, girdling at pit hardening stage, girdling 15 days before harvesting showed lower pulp carotenoid content than control except treatment girdling at full bloom. The maximum carotenoid content 10.46 mg/100 g pulp wt. was observed in treatment of girdling at full bloom stage (T_2) which was significantly higher to control and other remaining treatments (Table 4) .The minimum carotenoid content was observed in girdling at pit hardening (T_4). The improvement in fruit quality in terms of carotenoid at pit hardening might be due to interaction between anthocyanin and carotenoid. Rivas et al. (2011) also showed that girdling significantly increased leaf carotenoids, carotenoids: chlorophylls ratio and xanthophylls content in citrus.

Table 3. Effect of girdling on acidity (%) and ascorbic acid (mg/100 g pulp) in plum cv. Kala Amritsari

Treatments	Acidity (%)			Ascorbic acid (mg/100 g pulp)		
	2022	2023	Pooled	2022	2023	Pooled
Control-T_1	1.45	1.52	1.49	4.59	3.66	4.13
Girdling at full bloom- T_2	1.65	1.62	1.64	4.32	3.1	3.71
Girdling after fruit set- T_3	1.36	1.4	1.38	4.81	3.86	4.34
Girdling at pit hardening stage- T_4	1.29	1.32	1.31	4.86	3.9	4.38
Girdling 15 days before harvesting- T_5	1.39	1.45	1.42	4.61	3.68	4.15
CD (p=0.05)	0.06	0.07	0.07	NS	NS	NS

Table 4. Effect of girdling on anthocyanin content (mg/100 g pulp wt.) and carotenoid content (mg/100 g pulp wt.) in plum cv. Kala Amritsari

Treatments	Anthocyanin content (mg/100 g pulp wt.)			Carotenoid content (mg/100 g pulp wt.)		
	2022	2023	Pooled	2022	2023	Pooled
Control-T_1	5.62	5.85	5.74	9.5	10.18	9.84
Girdling at full bloom- T_2	5.3	5.44	5.37	10	10.92	10.46
Girdling after fruit set- T_3	5.79	6.08	5.94	9.12	9.84	9.48
Girdling at pit hardening stage- T_4	5.89	6.18	6.04	9.02	9.75	9.39
Girdling 15 days before harvesting- T_5	5.68	5.96	5.82	9.15	10.05	9.6
CD (p=0.05)	0.16	0.13	0.15	0.26	0.32	0.29

REFERENCES

AOAC 1990. *Official Methods of Analysis*, *15th Edn, Association of Official Analytical Chemist*, Washington, D.C.

Anonymous 2021. *Package of practices for fruit-flower-vegetable: production and preservation (Samagar Shifarishae)*, department of Horticulture, CCS HAU, Hisar, Haryana https://hau.ac.in/page/recommendation-in-package-of-practices.

Anonymous 2023a. *Ministry of Agriculture and Farmers Welfare*, Govt. of India, ON 1955. (https://www.hortharyana.com).

Anonymous 2023b. *Ministry of Agriculture and Farmers Welfare*, Govt. of India, ON 1955. (https://www.hortharyana.com).

Azizi S, Rana VS, Sharma S, Chauhan J and Kumar V 2022. Effect of girdling on yield and quality of Kiwifruit (*Actinidia deliciosa* Chev.) Raised through different propagation methods. *Indian Journal of Ecology* **49**(2): 496-501.

Basile T, Alba V, Gentilesco G, Savino M, Tarricone L 2018. Anthocyanins pattern variation in relation to thinning and girdling in commercial Sugrathirteen table grape. *Scientia Horticulturae* **227**: 202-206.

El-kenawy MA 2018. Effect of spraying jasmonic acid and girdling on growth, yield and improving fruits quality of Crimson seedless grapevine. *Egyptian Journal of Horticulture* **45**(1): 25-37.

Harborne JB 1973. Phenolic compounds. *Phytochemical methods: A guide to modern techniques of plant analysis* 33-88.

Hiscox JD and Israelstam GF 1979. A method for the extraction of chlorophyll from leaf tissue without maceration. *Canadian journal of botany* **57**(12): 1332-1334.

Hulme A C and Narain R 1993. The ferricyanide method for determination of reducing sugars. A modification of Hegedom-Jenson Hanes Technique. *Biochemical journal* **25**: 1051-61.

Kaur R, Kaur G and Singh A 2019. Impact of chemical thinning with branch girdling on fruit yield and quality of peach (*Prunus persica* L. Batsch) cv. Shan-i-Punjab. *Journal of Pharmacognosy and Phytochemistry* **8**(1S): 577-581.

Michailidis M, Karagiannis E, Tanou G, Samiotaki M, Sarrou E, Karamanoli K, Lazaridou A, Martens S and Molassiotis A 2020. Proteomic and metabolic analysis reveals novel sweet cherry fruit development regulatory points influenced by girdling. *Plant Physiology and Biochemistry* **149**: 233-244.

Nardozza S, Boldingh HL, Kashuba MP, McCaughan L, Philippe M, Wohlers M, McGhie T, Currie MB, Montefiori M and Richardson AC 2018. Effects of the manipulation of carbohydrate supply on fruit dry matter and colour development in a block-red *Actinidia chinensis* var. chinensis genotype. *Acta Horticulturae* 155-162.

Olivares D, Contreras C, Munoz V, Rivera S, Gonzalez-Agüero M, Retamales J and Defilippi BG 2017. Relationship among color development, anthocyanin and pigment-related gene expression in 'Crimson Seedless' grapes treated with abscisic acid and sucrose. *Plant Physiology and Biochemistry* **115**: 286-297.

Piccolo EL, Araniti F, Landi M, Massai R, Guidi L, Abenavoli MR and Remorini D 2021. Girdling stimulates anthocyanin accumulation and promotes sugar, organic acid, amino acid level and antioxidant activity in red plum: An overview of skin and pulp metabolomics. *Scientia Horticulturae* **280**: 109907.

Rivas F, Fornes F, Rodrigo MJ, Zacarías L and Agustí M 2011. Changes in carotenoids and ABA content in Citrus leaves in response to girdling. *Scientia Horticulturae* **127**(4): 482-487.

Solfanelli C, Poggi A, Loreti E, Alpi A and Perata P 2006. Sucrose-specific induction of the anthocyanin biosynthetic pathway in Arabidopsis. *Plant Physiology* **140**(2): 637-646.

Venkatarayappa T, Fletcher RA and Thompson JE 1984. Retardation and reversal of senescence in bean leaves by benzyl adenine and decapitation. *Plant Cell Physiology* **25**: 407-418.

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