Effect of foliar spraying with the growth inhibitor paclobutrazol on the quality of Chandler strawberry (*Fragaria ananassa*) under Punjab subtropics

Abstract: Thefieldexperimentconductedduringthe Rabiseasonof2022aimedtoinvestigatethe impact of foliar spray with the growth retardant paclobutrazol at various timings on thestrawberrycultivarChandler(*Fragariaananassa* Duch).Theexperimentaldesignemployeda Randomized Block Design (RBD) witheighttreatments,eachreplicatedthreetimes. Paclobutrazol was administered at different intervals, specifically at 110, 115, 120, 125, 130,135, and 140 days after planting, along with a control group receiving no spray. The resultsdemonstrated a significant influence of Paclobutrazol spray timing on the quality parameters. Amongthedifferenttreatmentswiththeplantgrowthretardant, Treatment4(PBZ250pp mat125 days after planting) exhibited the highest values for fruit length (31.40 mm), fruit width(25.70 mm), fruit thickness (1.79 mm), fruit weight (12.03 g), Total Soluble Solids (TSS)(9.50°Brix), Firmness (1.92 N) and Titrable Acidity (2.56%) whereas lowest values observed in the control.

Keywords: Growth retardant, Paclobutrazol, *Fragaria ananassa*, Chandler,Fruit Quality

Introduction: Strawberry (*Fragaria ananassa* Duch) is one of the most widely consumed andwell-likedberryfruits. Ithasapleasanttaste,adelicateflavor,andapleasingappearance,all ofwhich contribute to its popularity. Strawberries, in addition to their delightful andsensory qualities, can be categorized as a functional fruit due to their high concentration ofimportant nutrients and phytochemicals. These elements not only enhance the taste of thefruit, but also play an important role in supporting human health and overall well-being**(*D, Urso,Get al.*, 2015)**. Strawberry fruit quality as well as customer acceptance is determined by the fruit's size which comprises of length and breadth, with, color development, taste, texture, and flavor. Thefruit ingredientsresponsible for the overall strawberry flavor are sugar, organic acidsince their balancedefines the fruit's charm and pleasant taste**(*Domingues, A.R et al.*, 2018)**. Strawberry farming is a global agricultural technique that takes place in a variety of climates and places around the world. This tasty andnutritious fruit, famed for its sweet and tangy flavor, grows best in well-drained soil andtemperatetocooltemperatures. Majorstrawberry-producingcountriesincludetheUnitedStates, where states like California play a critical role, and China, where provinces like Shandong produce a substantial amount. Spain, Mexico, Egypt, and South Korea are all significant contributors to the global strawberry market. Strawberry farming necessitates meticulous attention to details such as irrigation, fertilization, and pest control. The fruit is cultivated on fields, but in some areas, new approaches like as high tunnels or greenhouse farming are used to lengthen the growing season. Strawberries are recognized not just for their exquisite taste but also for their nutritious content, making them a sought-after crop

in international markets.

Paclobutrazol (triazole derivative), a growth inhibitor, is commonly used to regulategrowth and development by altering associated biochemical and physiological processes. Bysuppressing gibberellin manufacture at the kaurene stage, it has been successfully used toinduce and regulate flowering, fruiting, and plant vigor in numerous fruit crops, resulting inreduced vegetative growth, promising early and copious flowering, and improved quality.When applied beforeflowering, it promotes strawberry growth, yield, and quality. Its useincreases the number of blooms per plant, the number of runners and plantlets per runner, thenumber of berries set and the berries yielded **(*Pandey, A.K et al.*, 2020*).*** Keeping inview thethat timing of application of paclobutrazol will effectquality of strawberry, the current study was carried out to investigate theviability of applying Paclobutrazol at various spray timings on the quality of strawberry cropsinPunjab subtropics.

MaterialandMethods: The studywasconductedoutdoorswithinthe premisesoftheDepartment of Agriculture's Research Farm at Sant Baba Bhag Singh University in Jalandharduring the 2022-2023 period. Its objective was to investigate the impact of varying the timingof foliar spray with Paclobutrazol on the overall quality of strawberries (*Fragaria ananassa*Duch)oftheChandlercultivar**.**Thelocationof thesiteisspecifiedbythecoordinates31.4220North and 75.8087 East. Raised beds, characterized by a finely cultivated soil texture anddevoid of weeds and grasses, were meticulously prepared and covered with black polythenesheetingformulching.RobustrunnersoftheChandlercultivarwereacquiredfromtheRH RSSresearch station in Bhaderwah, Jammu and Kashmir and were planted during the fortnight ofOctober with a 45 cm recommended spacing. Across all experimental treatments, a uniformapplication of the recommended dosage of manures and fertilizers, coupled with consistentpracticesofirrigation,weeding,andhoeing,wasmaintained.Theexperimentallayoutfoll owedarandomizedblockdesign(RBD)withthreereplications.Eachplotmeasured4x3meters.

Thetreatmentgroups wereasfollows:T0-control(nospray),T1-PBZ@250ppm110daysafter planting, T2 - PBZ @ 250 ppm 115 days after planting, T3 - PBZ @ 250 ppm 120 daysafter planting, T4 - PBZ @ 250 ppm 125 days after planting, T5 - PBZ @ 250 ppm 130 daysafter planting, T6 - PBZ @ 250 ppm 135 days after planting, and T7 - PBZ @ 250 ppm 140days after planting. Foliar spraying of Paclobutrazol 250 ppm recommendedwas initiated in early February andcontinued until the beginning of March. Observations were recorded at harvesting stage on different qualityparameters (these are all studied the quality parameters of strawberry crop because the length , width and thickness decide the physical appearance of the fruit and TSS and Acidity decide the taste and flavour of the fruit)likefruitlength(mm),fruitwidth(mm) and fruitthickness(mm) were calculated with the help of Vernier calipers. Fruitweight(g) was measured by using weighing machine. TSS(°Brix) was calculated by using a digital refractometer. AOAC's suggested approach was used to determine the Titrableacidity(%). Firmness(N) was measured with the help of digital penetrometer.According to the statistical process for Agricultural Research, the mean values of the data will be subjected to analysis of variance. Randomized Block Design. Utilising a method and algorithms, various statistical parameters were computed. The mean of the qualities was compared using ANNOVA (Analysis of Varience). (Hoshmand, R. 2017)

Plate1Raisingofseed beds

Plate2Manuring

Plate3Applicationoffertilizers

Plate4Mulching

	
Plate5Plantation	**Plate6Irrigation**
	
Plate7FloweringStage	**Plate8FruitingStage**

ResultsandDiscussion

A):Influenceofpaclobutrazolon physical qualityparametersofstrawberryplant.

The data recorded from 2022, shown in Table 1 and 2 indicate that the time of application of paclobutrazol significantly affected the physical quality parameters*viz*.fruit length, fruit width, fruit thickness, fruit weight and firmnessof the strawberry (*Fragaria ananassa*Duch) cv.Chandler.

Table1:Effectofapplicationofgrowthretardant(paclobutrazol)atdifferenttimingson physical qualityparametersofstrawberrycv. ChandlerunderPunjabconditions.

Treatments	Fruitlength (mm)	Fruitwidth (mm)	Fruitthickness (mm)	Fruit weight(g)	Firmness (N)
T0	17.20	16.10	1.49	7.36	1.62
T1	20.40	19.20	1.55	8.90	1.74
T2	24.50	20.50	1.62	9.50	1.76
T3	27.70	23.90	1.71	10.60	1.79
T4	**31.40**	**25.70**	**1.79**	**12.03**	**1.92**
T5	29.30	23.50	1.75	11.20	1.89
T6	29.40	23.20	1.72	10.60	1.84
T7	28.20	22.10	1.69	10.03	1.80
CD (0.5%)	1.56	0.91	N/A	1.05	N/A

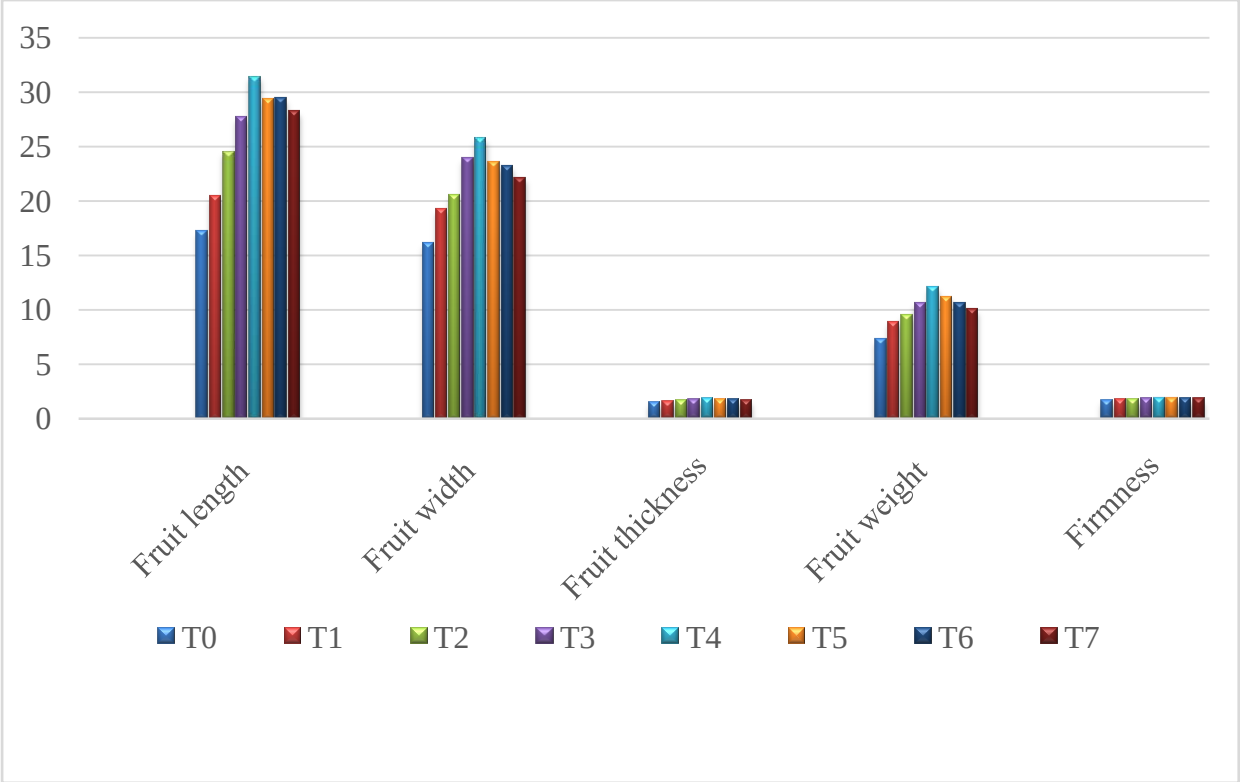

Fig1–Fruit length(mm),Fruitwidth(mm),Fruitthickness(mm), Fruitweight(g) and firmness (N).

It was found that spraying paclobutrazol at varied intervals had a significant influence on fruit length, fruit width,fruit weight and firmness. All these parameters showed an increasing trend from treatment T0 (Control) to treatment T4 (PBZ 250 ppm 125 days after planting) . T4 (PBZ 250 ppm 125 days after planting) recorded the maximun fruit length (31.40 mm), fruit width (25.70 mm) andfruit weight (12.03g)while for treatments T5 tot T7 (PBZ 250 ppm application after 130 to 145 days after planting) there was decrease in these parameters whereas T0 (control) yielded the shortest fruit length, fruit width, fruit weight. Data also showed that all treatments where paclobutrazol was applied outperformed better than the control. However fruitthickness and firmness does not have significant effect of sprayingpaclobutrazolatvariousintervals althoughslight increase in thickness and firmness as compared in the control has been recorded. The treatment T4 (PBZ 250 ppm 125days after planting) produced the thickest fruit (1.79 mm) with highest firmness (1.92 N) while minimum was recorded in T0 (control) yielded the smallestfruit thickness and firmness. The increase in fruit length and width also have been noted by**(*Kumraetal.*, 2018).** The identical values of fruit thickness and fruit weight were also obtainedby **(*Al-Raisyetal.*, 2010).**The same results were also observed by**(*Gine Bordonaba& Terry*, 2009).**

As it is known fact that paclobutrazol stops vegetative growth in plants and promotes reproductive growth, due to vegetative growth retardation photo assimilates are diverted towards reproductive parts resulting in increase in cell growth and meatbolities. Also maximum increase in length, width and weight of the fruit of strawberry at 125 days after planting may be attributed due tothe optimum balance between vegetative shoot and reproductive growth at

which maximum photassimilates would have been available to the plant for increase in physical parameters.

B):Influenceofpaclobutrazolon Chemical qualityparametersofstrawberryplant.

Table2Effectofapplicationofgrowthretardant(paclobutrazol) at different timings onchemical quality parametersofstrawberrycv. ChandlerunderPunjabconditions.

Treatments	TSS(°Brix)	TitrableAcidity(%)
T0	6.60	2.20
T1	7.50	2.39
T2	7.60	2.45
T3	8.00	2.51
T4	**9.50**	**2.56**
T5	8.90	2.48
T6	8.83	2.46
T7	8.50	2.44
CD (0.5%)	1.43	N/A

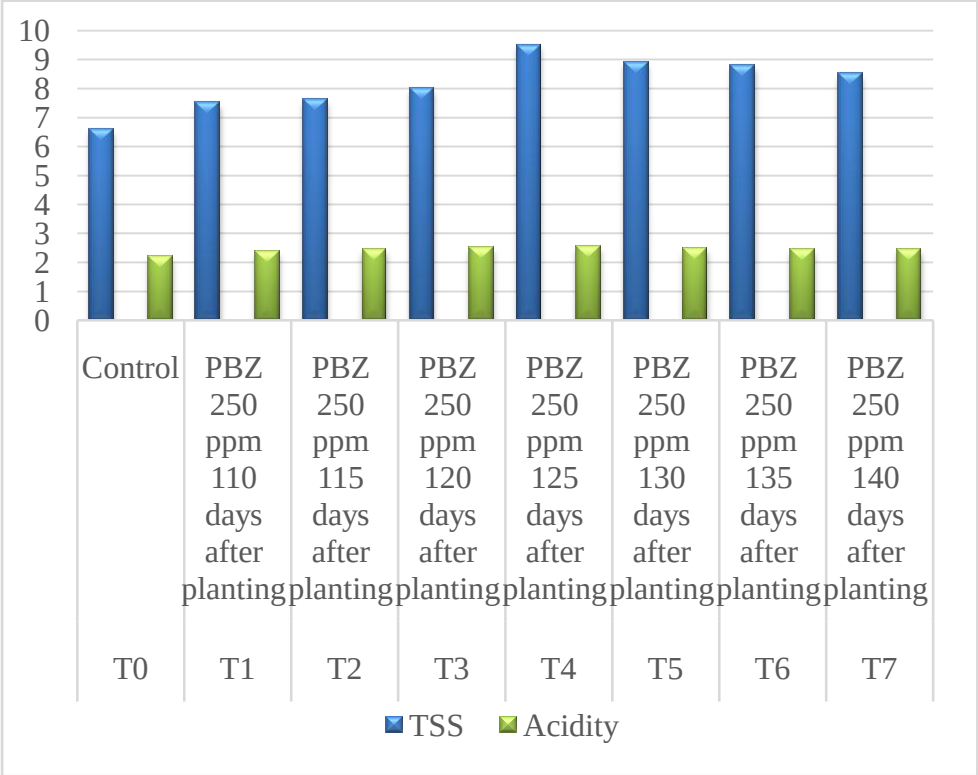

Fig2–TSS (°Brix)andTitrableacidity(%).

It was found that spraying paclobutrazol at varied intervals had a significant influence on Total Soluble Solids. This parameter showed an increasing trend from treatment T0 (Control) to treatment T4 (PBZ 250 ppm 125 days after planting) . T4 (PBZ 250 ppm 125 days after planting) recorded the maximun TSS (9.50 °Brix**)**while for treatments T5 to T7 (PBZ 250 ppm application after 130 to 145 days after planting) there was decrease in TSSwhereas T0 (control) yielded the shortest TSS. Data also showed that all treatments where paclobutrazol was applied outperformed better than the control.The same results were also obtained by **(*Abolfazl et al.*, 2017).**Using phenolphthalein as an indicator, ten mililitres of filtered juice was titrated against N\10 NaOH solution. The arrival of the pink coloursignalled the finish line. One ml of N\10 NaOH, which is equal to 0.0064 g of anhydrous citric acid, was used to compute the total titrable acidity in terms of citric acid.However Titrable Acidity does not have significant effect of sprayingpaclobutrazolatvariousintervals although slight increase in acidity as compared in the control has been recorded. The treatment T4 (PBZ 250 ppm 125days after planting) produced the highest level of acidity (2.56%) while minimum was recorded in T0 (control).There was no discernibleimpact discovered.Thesame outcomes were also seen by**(*Gine Bordonaba& Terry,* 2009)**.

Conclusion

According to the preceding explanation, growth inhibitors have a typical impact on plantarchitecture intermsofyieldandqualitycontributingcharacteristicswhentakenat theappropriatetimeanddose.So,forthesubtropicalconditionofPunjab,farmersareadvisedthattheide altimetoapplytheplantgrowthinhibitor paclobutrazol@250ppmamongthevariousspraytimingsis125daysafterplantingbecauseitproduces betterfruitqualityandhighyield,whichwillfurther helpin improvingfarmers'profitability.

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