Biostimulant:ItsEffectonthegrowthandsurvivalofasexuallypropagatedmango(*Mangiferaindica*L.) Cv. Alphonso

Abstract:TheKokan beltofMaharashtra, Indiais hometoover400nurseriesproducing more than1millionhighqualitymangoplantingmaterialsannually.Toenhancethesurvivalrateand growthofmangograftsatthenurserystage,astudywasconductedas"Biostimulant:ItsEffect onthegrowthandsurvivalofasexuallypropagatedmango(*Mangiferaindica*L.)"Cv.Alphonso duringAugust2023toAprile2024atDr.BalasahebSawantKonkanKrishiVidyapeeth,Dapoli, Maharashtra,India.Theexperiment,designedinafactorialrandomizedblockdesign,tested26 treatmentinteractionsinwhichNATCA(10.00%)+folicacid(0.2%)combination@1ml/Lat 60 days interval) performed best in terms of plant growth parameters and also reduced cost of productionofmangografts Cv.AlphonsofollowedbyChitosan@150ppmat60daysinterval also showed maximum B:C (1.49) and maximum net profit.

Keywords:mangograft,Alphonso,biostimulant,applicationinterval,survival

Introduction

Mango, botanically known as *Mangiferaindica*L. and belonging to Anacardiaceae family, is widely regarded as the King of Fruits (Yadav and Singh, 2017). It is extensively cultivated in tropical and subtropical regions of India, which is also home to diverse range of mango varieties. Notably, the Coastal Konkan belt of Maharashtra is recognized as one of India'spremiermango-growingregions.Indiaisshifttowardshigh-densitymangoplantations and has created a surge in demand for premium planting material. Fortunately, the Konkan region is well-equipped to meet this demand, with over 400 nurseries producing more than 1 millionhigh-qualitymangoplantsannually.Dr.BalasahebSawantKonkanKrishiVidyapeeth hasplayedapivotalroleinthissuccess,pioneeringtheinnovativestonegraftingtechniquefor mango cultivation. Through its comprehensive training programs, the university has also empowered a skilled workforce to support the expansion of mango cultivation and meet the increasing demand for quality plants.

Biostimulantare increasingly recognized for their beneficial effects on plant growth, enhanced productively and ability to mitigate both biotic and abiotic stresses, leading to their growing importance in agriculture. In Konkan region, previous research focused on nutrient enrichment through media to improve graft growth in nurseries, but investigations on the applicationofbiostimulantsandgrowthregulatorsinthiscontextwerelimited.Toaddressthis knowledge gap, a study was conducted to evaluate the effect of various biostimulant concentrations,includingCPPU,salicylicacid,NATCA(10%)+folicacid(0.2%)andchitosan appliedatmonthlyandbimonthlyintervalsontheperformanceofmangograftsCv.Alphonso.

Biostimulantofferacost-effectivesolution,astheydonotincreaseproductioncostsfor grafts. By improving graft survival rates with reduced concentrations or bimonthly applications, nurseryman can potentially increase profits.This may help the nurseryoperatorsto hasten the asexual propagation process of mango grafts enhancing survival rates of mangografts. It is environment friendly and practical to the part of nursery operators and farmers,thereby producing safe and quality planting materials. It also emphasizes the importance ofbiostimulant which aids in growth and development of mango grafts. Moreover, this can also lead to lower costs of grafts for farmers. Certain wild plants native to the Konkan region such as moringa, custard apple, neem, karnaj and ghaneri etc. exhibit growth-promoting properties in their leaves, which could be explored for future applications.

Material and Methods: The experiment was performed at nursery No 10. Department of Fruit Science, College of Horticulture, Dapoli, from August 2023 to April 2024. The experiment was carried out by factorial randomized block design with 26 treatment combination which were replicated by two times. FactorArepresents different concentration of biostimulant and factor B represents application interval.

FactorA:Differentconcentrationofbiostimulant

T_1-CPPU@15 ppm	T_6-Salicylicacid@500ppm	T_{11}-Chitosan@125ppm
T_2-CPPU@20 ppm	T_7–NATCA(10%)+folicacid(0.2 %)@ 0.5ml	T_{12}-Chitosan@150 ppm
T_3-CPPU@25 ppm	T_8-NATCA(10%)+folicacid(0.2 %)@ 1 ml	T_{13}–Control(withoutany spray)
T_4 -Salicylicacid@100ppm	T_9–NATCA(10%)+folicacid (0.2%) @ 1.5 ml	
T_5-Salicylicacid@250ppm	T_{10}-Chitosan@100ppmat 30	

FactorB:Spraying interval

S_1-Sprayingat30daysinterval(DI) S_2-Sprayingat60daysinterval(DI)

Initially, epicotyl grafted 50 grafts were selected. Application of biostimulantwas conducted by spraying from 30 days after grafting up to 6 months after grafting and the observation was recorded at 30 days interval up to 270 days after grafting and in values mentioned in table was at end of the experiment. Observation of all vegetative growth parameter (height, girth, leaf area) recorded at monthly interval, whereas root length, dry root weight of mango graft was noted at the end of experiment. The grafts of plants were handed overforexperimentationafter30days,markingthebeginningofthetrial.Initially,asmall

numberofgraftswerefoundtohavediedbyday30.Thesewererecordedbeforetheapplication and thesurvival (%)was determined fromthesurviving grafts at theend ofthe30 days study. Economics was calculated on the basis of cost of production of mango grafts and interval of application of biostimulant. The data after investigation statistically analysed by the method suggested by Panse and Sukhatme (1995).

Resultand discussion

At theend ofexperiment at 270 days aftergrafting, it was observed that all thegrowth parameter, survival and B:C was significantly influence by biotimulant and its interval of application.

Effectofbiostimulantanditsintervalofapplicationonheightofmangografts Cv. Alphonso

The data related to effect of biostimulant and its interval of application on height of mango grafts have shown inTable 1.The interaction effect at 270 DAG, on height of mango graft was noted significant and $T_{11}S_1$ (Chitosan @125 at 30 DI) recorded maximum height (45.15cm)atparwithT_8S_2(NATCA+folicacid@1mlat60DI)(43.73cm)andlowestheight (31.38 cm) and (31.75 cm)was notedin$T_{13}S_2$(Control without any spray) and$T_{13}S_1$(Control without any spray) treatment.

Monthly application of chitosan at 125 ppm boosted plant growth by stimulating hormonesandmakingmineralsmoreavailable.Dovel*etal.*(2023)Chitosanapplicationhelps to synthesis of auxin which known for its apical dominance which might helped to plant to grow. Bimonthly application of T_8S_2(NATCA+ folic acid @ 1 ml at 60 DI) also produced similar results to chitosan application. NATCA+ folic acid is also the great source of amino acid,folicacidalsohelpstosynthesisofvariousgrowthhormones(GA_3,auxinandcytokinin) Hota*et al.* (2019) which might be helped for increased height grafts. Similar results reported byEl-Tanahy*etal.*(2012)incowpea,notedmaximumheight(55.01cm)bytheapplicationof chitosan and El-miniawy*et al.* (2013) in strawberry noted maximum height (23.13 cm) and (23.83 cm) during two respective seasons.

Effectofbiostimulantanditsintervalofapplicationongirthofmangografts Cv. Alphonso

Datarelatedtogirthwasgiveninin Table1.At270DAG,themaximumgirth(11.66mm)was reportedinT_6S_1(Salicylicacid@500ppmat30DI)atparwith$T_{10}S_2$(Chitosan@100ppmat

60 DI)(11.64 mm) and $T_{11}S_1$(11.38 mm) and the lowest girth (8.60 mm) and (8.67 mm) was noted in $T_{13}S_2$and $T_{13}S_1$(Control) treatment.

DuringtheinvestigationperioditwasobservedthatattheendT_6S_1(salicylicacid@500ppm at 30 DI) showed best results. Salicylic acid plays a key role in plant defence and regulates various physiological processes. It also contributes to the synthesis of growth hormones, including auxin and gibberellin which might be increasing stem diameter through stem elongation. Similar results found by Akram*et al.* (2022) in *Antirrhinum majus*and noted maximum height (91.33 cm) by the application of salicylic acid

Effectofbiostimulantanditsintervalofapplicationonleafarea(cm^2)ofmangografts Cv.Alphonso

DatadespiteinTable1.At270DAG,themaximumleafarea(818.57cm^2)wasrecorded in$T_{10}S_1$(Chitosan@100ppmat30DI)followedbytreatmentT_8S_2(760.35cm^2)andminimum leaf area (481.40 cm^2) and (487.72 cm^2) was noted in $T_{13}S_1$and $T_{13}S_2$control treatments.

The study found that the biostimulant interaction effect and application interval had a significant impact on the leaf area of mango grafts.Application of chitosan 100 ppm on a monthlybasisgavebestresultsfollowedbyNATCA+folicacidonbimonthlybasisapplication also gave significant results in terms of leaf area of mango grafts. Chitosan applied monthly enhanced amino acid and nitrogen production, leading to increased synthesis of auxin and cytokinin hormones. This, in turn, stimulated growth, producing more leaves with increased length, width and expanded leaf area. Similar reported by Abul-magd*et al.* (2023) in *Aglaonemacommutatum*) and noted that chitosanapplication gave maximum leaf area (36.38 cm^2) and Hota*et al.* (2024) in apricot plant noted that NATCAin combination with CPPU or sole increased leaf area of mango grafts.

Effectofbiostimulantanditsintervalofapplicationonrootlengthofmangografts Cv. Alphonso

Data related to roots and survival was given inTable 2.All the root observations were recorded at the end of experiment at 270 DAG. Interaction effect of biostimulant and its applicationintervalshowedsignificanteffectonrootlengthofmangograft.Themaximumroot length (18.75 cm) was found in T_8S_2at par with $T_{10}S_2$(18.50 cm) and $T_{11}S_1$(17.55 cm) treatments while, the minimum rootlength (12.50 cm) and (13.70 cm) was noted in$T_{13}S_1$and $T_{13}S_2$control treatment.

Amino acid in NATCA helped to synthesis of hormones like GA and IAA. IAA was well known for its ability to form new roots and promote root growth, which might increase the root length of mango grafts.

Effectofbiostimulantanditsintervalofapplicationondryweightofrootofmango grafts Cv. Alphonso

The significant result was observed in interaction effect and maximum dry weight (12.92g)wasnotedinT_8S_2treatmentatparwithT_6S_1(12.90g),$T_{10}S_2$(12.80g),$T_{11}S_1$(12.65 g),T_1S_1(CPPU@15ppmat30DI)(12.62g),T_5S_1(Salicylicacid@250ppmat30DI)(12.60 g)and$T_{12}S_2$(Chitosan@150ppmat60DI)(12.00)howevertheminimumdryweight(6.85g) and(7.05g)wasnotedin$T_{13}S_1$and$T_{13}S_2$controltreatment.

T_8S_2(NATCA+folicacid@1mlat60DI)whichgavesuperiorresults,evenitapplied at60daysintervalofapplication.NATCAacidcontainedhormonessuchasIAAandGA,with IAAstimulatingrootformationandpromoteshealthygrowthofrootswhichmightincreasethe dryweightofroot.Elbohy*etal*.(2018)in*Zinniaelegans*plantandnotedmaximumdryweight (8.66g)and(8.44g)bytheapplicationofsalicylicacidmeanwhileEbrahimpour*etal.*(2020) also reported in pistachio seedling that application salicylicacid increased dryweight ofroots up to 5 % to 33 %

Effectofbiostimulantanditsintervalofapplicationonsurvivalofmangograftsofroot of mango grafts Cv. Alphonso

Maximumsurvival(86.05%)ofmangograftswasreportedinT_6S_1atparwithT_9S_1(NATC A + folic acid @ 1.5 ml at 30 DI) (85.89 %) while minimum survival (49.32 %) and (51.89 %) was noted in $T_{13}S_1$and $T_{13}S_2$control treatment. Salicylic acid increased the grafts unionalsorelatedgraftingstressandaidsinrecoveryandestablishment.Thisallmightproduce healthy plant growth which might increase survival (%) mango graft.Thorat*et al.*(2018) in mango Cv. Kesar that application of salicylic acid 500 to 1000 mg/L increased the survival percentage of plant by (73.33 %) to (71.67 %).

Effectofbiostimulantanditsintervalofapplicationoncostofproduction(B:C)of mango grafts of root of mango grafts Cv.Alphonso

The cost of production application was shown inTable 3.The highest B:C (1.51) was noted in treatmentT_8S_2(NATCA+folic acid @ 1 ml at 60 DI) treatment with 1692.62 Rs net profitfollowedby$T_{12}S_2$(Chitosan@150ppmat60DI)andreportedmaximumB:C(1.49)

with 1829.60Rs net profit but T_8S_2treatment required lowest cost of production compared to all the treatment at 30- or 60-days application interval. However, the lowest B:C (1.10) and (1.06)wasnotedin$T_{13}S_1$and$T_{13}S_2$treatment.

Table1.Effectofbiostimulantanditsintervalofapplicationonheight(cm),girth(mm) and leaf area (cm^2) of mango grafts Cv. Alphonso

Treatments	Height(cm)ofmango graft at 270 DAG			Girth(mm)ofmango graft at 270 DAG			Leafarea(cm^2)ofmango graft at 270 DAG		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	40.55	36.25	38.40	10.92	10.29	10.61	651.78	572.02	611.90
T_2	35.70	36.13	35.92	10.24	9.57	9.90	727.70	530.35	629.03
T_3	37.50	33.00	35.25	10.47	9.70	10.09	697.17	578.52	637.85
T_4	36.45	35.00	35.73	10.47	9.68	10.07	576.52	612.79	594.66
T_5	38.50	38.00	38.25	10.38	10.93	10.65	582.77	656.02	619.40
T_6	37.60	37.30	37.45	**11.66**	11.07	11.36	673.08	735.53	704.31
T_7	35.25	39.05	37.15	10.14	10.45	10.29	513.71	687.54	600.62
T_8	37.00	43.73	40.37	10.11	10.60	10.35	605.42	760.35	682.89
T_9	35.40	37.23	36.32	10.58	10.13	10.35	625.20	697.77	661.48
T_{10}	42.93	39.08	**41.01**	11.28	11.64	**11.46**	**818.57**	683.58	**751.08**
T_{11}	**45.15**	35.28	40.22	11.38	10.78	11.08	735.46	552.97	644.22
T_{12}	40.45	35.20	37.83	10.33	10.36	10.34	641.59	599.50	620.55
T_{13}	31.75	31.38	31.56	**8.60**	8.67	8.64	481.40	487.72	484.56
Mean	**38.02**	36.66	-	**10.50**	10.29	-	**640.80**	627.28	-
-	S. Em±	C.D at5%	Result	S. Em±	C.Dat 5%	Result	S. Em±	C.Dat 5%	Result
T	0.29	0.85	SIG	0.06	0.17	SIG	0.30	0.86	SIG
S	0.04	0.13	SIG	0.01	0.03	SIG	0.05	0.13	SIG
T×S	0.58	1.70	SIG	0.12	0.34	SIG	0.59	1.73	SIG

Table2.Effectofbiostimulantanditsintervalofapplicationonrootlength(cm),dryweightof root (g) and survival (%) of mango grafts Cv. Alphonso

Treatment	Root length of mango graftsat270DAG(cm)			Dry weight of root of mangograftat270DAG (g)			Survival(%)ofmango grafts at 270 DAG		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	16.85	14.00	15.43	12.62	7.90	10.26	73.63	67.54	70.59
T_2	14.10	15.50	14.80	8.00	11.20	9.60	71.82	77.50	74.66
T_3	14.20	13.80	14.00	8.10	7.80	7.95	73.91	70.89	72.40
T_4	14.80	14.30	14.55	9.20	8.20	8.70	80.00	71.76	75.88
T_5	16.40	14.40	15.40	12.60	8.40	10.50	71.88	69.37	70.63
T_6	16.15	14.50	15.33	12.90	8.60	10.75	**86.05**	69.57	77.81
T_7	14.90	15.90	15.40	9.20	11.50	10.35	74.00	78.00	76.00
T_8	14.60	**18.75**	16.68	8.90	**12.92**	10.91	79.35	70.50	74.92
T_9	15.10	15.80	15.45	9.40	11.40	10.40	85.89	70.73	**78.31**
T_{10}	15.30	18.50	**16.90**	9.60	12.80	**11.20**	73.00	71.47	72.24
T_{11}	17.55	15.20	16.38	12.65	9.50	11.08	74.02	77.22	75.62
T_{12}	15.40	16.25	15.83	9.98	12.00	10.99	72.62	74.17	73.40
T_{13}	12.50	13.70	13.10	7.05	6.85	6.95	51.89	49.32	50.60
Mean	15.22	15.43	-	10.01	9.93	-	**74.47**	70.62	-
-	S. Em±	C.D	Result	S. Em±	C.D	Result	S. Em±	C.Dat 5%	Result
T	0.24	0.71	SIG	0.19	0.56	SIG	0.97	2.81	SIG
S	0.04	0.11	NS	0.03	0.09	NS	0.15	0.43	SIG
T×S	0.49	1.42	SIG	0.38	1.12	SIG	1.93	5.62	SIG

Table3.Effectofbiostimulantanditsintervalofapplicationoncostofproduction(B:C) of mango grafts of root of mango grafts Cv.Alphonso

Sr.No	Treatment	Total numberof grafts survived	Totalcost (Rs)	Gross return(Rs. 80× survive graft)	NetProfit (Rs)	B:Cratio
1.	T_1S_1	61	3833.77	4880	1046.23	1.27
2	T_2S_1	61	3987.31	4880	892.69	1.22
3	T_3S_1	68	4094.44	5440	1345.56	1.32
4	T_4S_1	68	3677.12	5440	1763.01	1.47
5	T_5S_1	64	3624	5120	1496	1.41
6	T_6S_1	67	3664.35	5360	1695.65	1.46
7	T_7S_1	58	3544.71	4640	1095.29	1.30
8	T_8S_1	65	3639.1	5200	1560.9	1.42
9	T_9S_1	61	3586.82	4880	1293.18	1.36
10	$T_{10}S_1$	62	3597	4960	1363	1.37
11	$T_{11}S_1$	61	3583.67	4880	1296.33	1.36
12	$T_{12}S_1$	60	3570.35	4800	1229.65	1.34
13	$T_{13}S_1$	47	3396.99	3760	363	1.10
14	T_1S_2	56	3642.22	4480	837.78	1.22
15	T_2S_2	59	3723.97	4720	996.03	1.26
16	T_3S_2	56	3725.71	4480	754.29	1.20
17	T_4S_2	61	3583.72	4880	1296.28	1.36
18	T_5S_2	59	3583.82	4880	1296.18	1.36
19	T_6S_2	59	3557.33	4720	1162.67	1.32
20	T_7S_2	61	3584.18	4880	1295.82	1.36
21	T_8S_2	62	3267.38	4960	1692.62	**1.51**
22	T_9S_2	58	3545.24	4640	1094.76	1.30
23	$T_{10}S_2$	58	3545.24	4640	1094.76	1.30
24	$T_{11}S_2$	67	3663.8	5360	1696.2	1.46
25	$T_{12}S_2$	69	3690.34	5520	1829.66	1.49
26	$T_{13}S_2$	45	3370.33	3600	229.67	1.06

Conclusion

From the present study it can be concluded that application of NATCA(10 %) +folic acid (0.2 %) @ 1 ml/L at 60 days interval for 180 days to mango grafts of Alphonso and obtained superior results in plant growth parameter like (height, girth, root length and dry weightofroot)byreducingcostofproductionwithhighestB:C(1.51)overallotherapplication ofbiostimulantat30-or60-daysintervalfollowedbyChitosan@150ppmat60daysinterval also showed maximum B:C (1.49) and maximum net profit.

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