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Use of plant growth promoting microorganisms in plant propagation

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Abstract
Microorganisms that can increase plant growth and productivity are termed as plant growth promoting microorganisms. Plant growth promoting microorganisms includes atmospheric N_2 fixers, P solubilizers, P mobilizing microorganisms, plant pathogens suppressing microorganisms *etc*. They are ecofriendly and secretes growth promoting hormones and secondary metabolites which help in mobilizing various micronutrients (Arshad, *et al.*, 1998) which are needed to the plant and to overcome several root borne diseases.
Plant propagation is the reproduction or duplication of a plant from mother plant.
The cutting, budding, grafting, layering *etc*. are the important methods of plant propagation.

Keywords: N_2 fixers, P solubilizers, P mobilizing microorganisms and plant pathogens suppressing microorganisms

Introduction
Soil is considered as a store house of microbial activity. Some beneficial microorganisms preferentially associate on roots of crop plants. Plant roots constantly alter the rhizospheric soil environment by secreting root exudates. Converts non available form of nutrients to available form. It helps in uptake of nutrient elements from soil. They are very safe for human beings, animals and environment Plant growth promoting microorganisms application in cuttings improves the root development.
Root exudates consists of sugars, organic acids and secondary metabolites. Plants provide the major source of carbon for maintenance of microbial community in the rhizosphere micro flora.
More over the plant itself depends on the ability of microbial community to make required nutrients available including Nitrogen, Phosphorus and Iron some soil bacteria preferentially associate with the roots of crop plants and exert beneficial effects on their hosts.

Factors responsible for stimulation of plant growth:
1. Ability to produce or change the concentration of the plant hormones like indole acetic acid (IAA), Gibberellic acid, cytokinins and ethylene
2. Nitrogen fixers: some microorganisms like Rhizobium which fixes atmospheric nitrogen
3. Antagonism against phytopathogenic microorganism Solubilisation of mineral phosphates and other nutrients: like Zn, P, Mo, B, S, Cu.

Mechanism of plant growth stimulation:
1. Increased availability and uptake of nutrients: Zn, P, Mo
2. Siderophore production: Fe chelating bacteria
3. Production of plant growth promoting substances: indole acetic acid (IAA), Gibberellic acid, cytokinins and ethylene.

Siderophore produced by plant associated rhizoshere bacteria

S. No	Siderophore	Bacteria
1	Pyoverdin	*Pseudomonas flourescens Pseudomonas putida*
2	Catechols a)Agrobactin b)Enterobactin c)Azotochelin	 *Agrobacerium tumifaciens* Enterobaceriaceae family *Azotobacter vinelandii*
3	Other types Rhizobactin Citric acid Azotobactin	 *Rhizobium meliloti* *Bradyrhizobium japonicum* *Azotobacter vinelandii*

Important plant growth promoting microorganisms:

Nitrogen fixers

1. Aerobic
   - Symbiotic: ex: *Rhizobium sp. Frankia*
   - Asymbiotic: ex: *Azotobacter sp.*
2. Facultative anaerobes ex: *Bacillus sp*
3. Microaerophyllic ex: *Azospirillium sp.*

Importance

1. These organisms secrete growth promoting substances like auxin IAA, Indole-3-acetamide (IAM) which helps to increase root biomass, root branching and root hair development
2. These organisms fixes atmospheric nitrogen
3. Resistant to diseases
4. Increases crop yield

P- solubilisers

Bacillus megaterium, Pseudomonas fluorescence, Aspergillus niger, Thiobacillus ferroxidans, Thiobacillus thioxidans, Trichoderma sp., Streptomyces

Importance

1. These organisms secretes growth promoting substances are produces organic acids auxin, IAA,Indole -3-acetamide which helps to enhance rooting They secretes citric acid, glycolic acid, fumaric acid, oxalic acid, succinic acid
2. Produces siderophores: Fe chelating compounds produced by PSB that chelate iron from iron phosphates and there increases P availability in acid soils
3. Resistant to plant diseases
4. Enhances root biomass and photosynthetic area

P-mobilisers

1. Ectomycorrhiza: Ex: *Pisolithus tinctorus, Boletus sp*.
2. Endomycorrhiza: Ex: *Glomus sp. Scelerocystis sp. Acaulospora sp. Entrophosphora sp. Gigaspora sp. Scutellospora pellucida*
3. Ericoid: Ex: *Pezizella ericae*
4. Orhid: Ex: *Tulasnella* ***sp.***

Importance

Helps in Uptake of nutrients Zn, Mo, Fe, Cu
Helps in uptake of water
Helps to overcome transplantation shock
Protects the plant from root born pathogen
Secretes growth promoting substances
Plants are drought tolerant

Plant growth promoting microorganisms acts as a biocontrol agents

Biocontrol	Crop	Causal organisms/disease
Pseudomonas fluorescens	Cotton Cotton Cotton	Damping off *Rhizoctonia solanii* *Pythium ultimum*
Pseudomonas putida	Radish Beans Potato	Fusarium wilt *Fusarium solanii* *Erwinia carotovora*
Bacillus subtilus	corn	*Fusarium roseum*
Rhizobium and Bradyrhizobium	Soybean Mungbean Sunflower	*Macrophomina phaseolina* *Rhizoctonia solanii* *Fusarium solanii*
Bacillus subtilus	Mungbean	*Meliodogyne javanica*

Types of propagation:

I) Sexual propagation, ex: seed formation.

ii) Asexual propagation ex: cutting, budding, grafting, layering.

Cuttings

Pieces of vegetative material obtained from any of the three primary plant organs like stem, leaf or root.

Grafting

A type of asexual propagation in which parts of two different plants are joined so that they continue their growth as one plant.

Budding

Also called pseudografting.

Difference between budding and grafting is that budding uses a single bud as the scion where as grafting uses a piece of plant material consisting of several buds.

Layering

It is also called as modified cuttings

Roots or stems can be propagated by layering

Propagation by underground structures:

Bulbs, corms, rhizomes, tubers

Symbiotic responses of cashew root stocks to different VAM fungi

Table 1: Effect of soil inoculation with different VAM fungi on plant height, stem girth and total biomass cashew.

Treatment	Plant height (cm)	Stem girth (cm)	Total biomass (g/plant)
Acaulospora laevis	45.95	0.84	10.93
Gigaspora margarita	40.60	0.78	8.98
Gigaspora caledonicum	42.14	0.78	8.98
Gigaspora fasciculatum	43.33	0.76	9.09
Glomus intraradices	41.24	0.76	8.79
Glomus leptotichum	42.03	0.75	8.23
Glomus macrocarpum	41.14	0.78	8.55
Glomus mosseae	43.45	0.83	9.86
Scutellospora calospora	42.28	0.80	8.69
	39.03	0.69	8.00

Lakshmipathi *et al.*, 2000 [3]

Conclusion

Cashew plant responded quite well to inoculation with vesicular arbuscular mycorrhizal fungi. Plant height, stem girth and total biomass was more in VAM inoculated plants compared to uninoculated plants. Plant height was significantly more in plants inoculated with *Acaulospora laevis, Glomus mosseae* and *Glomus fasiculatum* compared to uninoculated control plants.

Table 2: Effect of soil inoculation with different VAM fungi on plant P content, mycorrhizal root colonisation of cashew and spore numbers in root zone soil of cashew.

Treament	Spore no/50ml soil	Root colonisation(%)	Total P uptake (mg/plant)
Acaulospora laevis	198	61.96	0.51
Gigaspora margarita	170	45.06	0.44
Gigaspora caledonicum	154	49.93	0.32
Gigaspora fasciculatum	130	50.87	0.40
Glomus intraradices	130	39.08	0.29
Glomus leptotichum	168	44.01	0.33
Glomus macrocarpum	145	41.71	0.34
Glomus mosseae	161	59.66	0.50
Scutellospora calospora	146	40.82	0.35
Uninoculated control	89	23.70	0.23

Lakshmipathy *et al.*, 2001

Conclusion

Mycorrhizal root colonization and spore numbers in root colonization and spore numbers in root zone soil were significantly more in the case of plants inoculated with *Acaulospora laevis* and *Glomus mosseae* compared to uninoculated control

Impact of inoculation of microorganisms on rootability of pomegranate cutting

Table 3: Response of inoculation of different microorganisms, growth regulators and growth media on percentage of rooting in pomegranate cultivars Jyothi and RCR-1

S. No	Treatments	Jyothi	RCR-1	Mean
1	*Azospirillum brasilense*	36.47	43.71	40.09
2	*Azospirillum lipoferum*	23.30	40.02	31.66
3	*Azotobacter sp*	24.07	41.95	33.01
4	*Tricoderma harzianum*	56.68	55.67	56.18
5	IBA 200 ppm	33.23	42.21	37.72
6	IAA 200 ppm	30.33	40.69	35.50
7	NFB broth	21.53	36.47	29.00
8	Waksman no 77broth	17.32	33.08	25.20
9	Potato dextrose broth	13.53	20.27	16.90
10	Control (untreated)	21.09	16.76	18.93
	mean	27.76	37.08	32.42

Satish kumar *et al.*, 2001

NFB: Nitrogen free bromothymol blue broth

Table 4: Response of inoculation of different microorganisms, growth regulators and growth media on number of primary roots per cuttings in pomegranate cultivars Jyothi and RCR-1

S. No	Treatments	Jyothi	RCR-1	Mean
1	*Azospirillum brasilense*	29.67	33.00	31.33
2	*Azospirillum lipoferum*	23.66	27.67	25.67
3	*Azotobacter sp*	16.33	22.33	19.33
4	*Trichoderma harzianum*	30.67	39.33	35.00
5	IBA 200 ppm	25.33	23.67	24.50
6	IAA 200 ppm	25.33	23.67	24.50
7	NFB broth	13.33	19.67	16.50
8	Waksman no 77 broth	7.67	15.67	11.67
9	Potato dextrose broth	12.33	17.00	14.67
10	control	6.33	7.33	6.83
	Mean	19.07	22.97	21.02

Satish kumar *et al.*, 2001

Table 5: Response of inoculation of different microorganisms, growth regulators and growth media on length of longest primary root (cm) cutting of pomegranate cultivars Jyothi and RCR-1

S. No	Treatment	Jyothi	RCR-1	Mean
1	*Azospirillum brasilense*	19.13	17.17	18.15
2	*Azospirillum lipoferum*	9.80	13.07	11.43
3	*Azotobacter sp*	13.27	15.73	14.50
4	*Trichoderma harzianum*	23.13	17.83	20.48
5	IBA 200 ppm	20.57	16.47	18.52
6	IAA 200 ppm	20.20	17.00	18.60
7	NFB broth	10.50	11.77	11.13
8	Waksman no 77 broth	7.67	13.10	10.38
9	Potato dextrose broth	6.70	13.13	9.91
10	control	6.63	10.57	8.65
	Mean	13.76	14.58	14.17

Table 6: Concentration of auxin (IAA) produced by microorganisms.

Microorganisms	IAA concentration (g/ml)
Trichoderma harzianum	51
Azospirillum brasilense	32
Azospirillum lipoferum	21
Azotobacter sp	19

Table 7: Response of inoculation of different microorganisms, growth regulators and growth media on survival of rooted cutting (%) 90 days of planting

S. No	Treatments	Jyothi	RCR-1	Mean
1	*Azospirillum brasilense*	64.23	85.13	74.68
2	*Azospirillum lipoferum*	61.17	82.50	71.84
3	*Azotobacter sp*	57.23	81.30	69.28
4	*Trichoderma harzianum*	66.27	87.26	76.77
5	IBA 200 ppm	55.60	78.03	66.82
6	IAA 200 ppm	58.17	66.93	62.55
7	NFB broth	46.10	63.47	54.78
8	Waksman no 77 broth	33.90	50.10	42.00
9	Potato dextrose broth	35.13	38.53	36.83
10	control	32.63	35.50	34.07
	Mean	51.04	66.87	58.96

Satish Kumar *et al*., 2001

Conclusion

Among treatment imposed, the cuttings inoculated with *Trichoderma harzianum* had resulted in higher percentage of rooting, more number of primary roots and longest root length then other microorganisms and growth regulators treatments

respectively. The positive influence of these microorganisms may be attribute to early spouting of the microbial inoculated cuttings apart from gibberllic acid production which enhances the vegetative growth.

Table 8: Utilization of the Diazotroph, *Azospirillum* for inducing rooting in pepper cuttings Effects of *Azospirillum* on pepper cuttings, one month after treatment

Treatments	% of rooted cutting	No of roots/ cutting	Total lt of roots/ cuttings (cm)	Dry wt of roots (g)	Germinated cuttings (%)	lt of sprout/cutting (cm)	No. of fully opened leaves/cutting	Dry wt of sprout/ Cutting (mg)
Azospirillum	80	7.4	34.5	0.05	80	5.7	3.1	133
IBA 1000 ppm	80	16.0	82.1	0.09	37.5	1.7	0.5	6
Control	0	0	0	0	40	2.2	1.3	17

Govindan.M and Chandy K.C 1985 [2]

Conclusion

Treatment with IBA increased only root development. Though 80% of the plant treated with IBA developed roots, only 37.50% of them showed sprouting. On the other hand 80% of the plants treated with *Azospirillum* showed both rooting and sprouting, indicating the growth promoting effect of *Azospirillum*.

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