Review Article on Effect of Pre - Sowing Seed Treatment on Yield Attributing Characters and Seed Yield in Flower Crops

K. Natarajan

Associate Professor, KVK, Vridhachalam, Tamil Nadu Agricultural University, Vridhachalam, Cuddalore District - 606001, Tamilnadu, India

Email address: *natarajan_seed75[at]rediffmail.com, natssst2015[at]gmail.com*

Abstract: ***Management techniques are essential in production practices, especially pre - sowing seed management, which has been a focus for scientists to boost seed potential both in storage and field conditions. Rapid and uniform field emergence are critical for increasing yield, quality, and profit in annual crops. Pre - sowing seed invigoration, involving treatments such as seed fortification with growth regulators, nutrients, botanicals, pelleting, and osmotic priming, has shown to enhance crop yield by 10 - 15. However, standardization of these techniques is necessary, as seed responses vary based on chemical composition, concentration, treatment duration, and seed aging. The use of bioactive chemicals in pre - sowing treatments not only improves germination but also enhances the yield of economic parts such as flowers and seeds. Various studies have demonstrated the effectiveness of different chemicals and growth regulators, particularly gibberellic acid GA3, in promoting seed germination and vigor.***

Keywords: pre - sowing seed management, seed invigoration, growth regulators, germination enhancement, crop yield improvement

Management techniques are warranted in any production practices. Pre - sowing seed management practices have drawn the attention of the scientist from time immemorial for boosting the potentiality of the seed at store and field including nursery. Rapid and uniform field emergence is the two essential pre requisite to increase the yield, quality and ultimately the profits in annual crops (Parera and Cantliffe, 1994). Pre - sowing invigoration is one such technological highlight focused to the above goals. Pre - sowing seed invigoration treatments are numbered many by the researchers (Sundaralingam *et al*., 2001) and all are claimed to have invigourative effect at field for enhancing the yield of crop to a tune of 10 - 15 per cent (Vijayakumar *et al*., 1988). Some of the widely pronounced pre - sowing seed management techniques are seed fortification with growth regulators (Chandola *et al*., 1973), nutrients (Venkataraman *et al*., 1978), botanicals (Jegathambal, 1996), pelleting (Balaji, 1990), osmotic priming (Adegbuyi *et al*., 1981) seed infusion (Khan and Tao, 1977), stress management against alkaline condition (Blum, 1987) and pollutants (Agarwal and Hemalata, 1992). Adoption of any of this technique for a particular crop required standardisation work as the response of the seed to the pre - sowing treatment varies with chemical, concentration and duration of the treatment. Standardization is even stressed based on the lot, as ageing is one another factor that modifies or alters the response of seed to any physical or physiological management technique (Sundaralingam *et al*., 2001).

Invigouration effect could be imposed into the seed by application of bioactive chemicals for improving the endogenous level of the substance which in turn can improve the vigour of seed. These pretreatment with bioactive chemicals improves not only germination but also for the yield of economic part the flower and the seed in several instants. Austin *et al*. (1973), Chellapa and Karivaratharaju (1973), Padmajarao (1979), Jhorar *et al*. (1982), Seenu (1987), Begum *et al*. (1997) with their studies with different crop emphasized that pre - sowing fortification treatment with growth regulators such as GA_3, IAA and IBA were warranted as they enhanced the germination both at field and laboratory and the seedling emergence and establishment at field. Jerlin *et al*., (1997) also reported that growth and development of a plant are under the control of various growth regulating substances and external application of a particular growth regulator could cause promotion or inhibition of growth depending upon the concentration of the applied solution (hormone or growth regulator) and many growth regulating substances had been tried to boost up the growth of various crops with varying degree of success (Hatano and Asakawa, 1964). The pre - sowing seed treatment recommended for invigourating the various flower seeds are tabulated as follows

Common name	Treatment	Effect	Authority
Seed crop			
Pansy	Soaking in GA_3 100 ppm for 24 h	Increased the number of seed, fruit, weight of seeds/fruit (31.59 mg) and weight of seed (1.21 g)	Bose and Kapur (1969)
	Seed soaking in GA_3 [at]100 - 200 mg/lit	Produced excellent germination	Renard and Clera (1978)
	Seed priming with PEG – 1.0 MPa for 7 days at 35ºC	Improved the germination to 51% than control (10%)	William (1991)
Marigold	GA_3 soaking for 30 min at 25 ppm	Greatest improvement in germination per cent, stem height, flower number, size and weight	Sharga *et al*. (1970)

Tagetes erecta	Seed soaking in 0.75% KNO_3	Improved the germination (89.5%) and vigour potential	Selvaraju and Selvaraj (1994)
		Improved the germination	Djewas and Staden (1990)
	Soaking seeds in 10, 000 mg/lit of humic acid	Improved the root and shoot fresh weight and germination	Hart Wigsen and Evans (2000)
Primula vulgaris	Chilling at 2. ºC for 4 weeks	Improved the germination per cent	Thompson (1970)
	Seeds are kept at 15 to 25ºC and soaked in 0.25% KNO_3 Plus light	Improved the germination and the seedlings are vigorous	Chavagnat (1981)

Common name	**Treatment**	**Effect**	**Authority**
Primula vulgaris	Seed soaking in 250 ppm GA_3 for 24 h	Increased the germination to 88 per cent compared to control (55%)	Miller and Holcomb (1982)
	Seed soaking in GA $_{4+7}$[at]10^{-4} m + BA (10^{-5} m)	Improved the germination	Finchsavage *et al.* (1991)
Geranium	Dehulled seeds with conc. H_2SO_4 for 5 - 8 minutes	Overcome the hard seeds	Heit (1971)
China aster	Seed inoculation with 1: 1 mixture of phosphobacteria	Advanced the plant development and increased the seed yield	Vorobeva (1977)
Rose	Presowing seed treatment with vitamin B2	Increase the germination by 51 per cent	Serebryakava and Kalanova (1977)
Balsam *Balsam verbena*	Seeds washed in running water for ½ hour and then soaked in 5 ppm IBA for 20 h	Increased the number of buds (30) and number of flowers	Agnihorti *et al.* (1964)
	Seed soaking in GA_3[at]100 - 200 mg/lit	Produced excellent germination	Renard and Clera (1978)
	Dry seed soaked for 24 h in saturated solution of diethyl sulphate	Decrease the plant height, number of branches, flowers and fruits per plant than control	Bose and Basu (1967)
	Seed soaking in water, IBA, IAA, GA, ascorbic acid and kinetin solution[at]100, 1, 10 µg/ml	100 per cent germination in water, 1 µg/ml of GA_3 and IAA treatment after 48 hours	Aeri and Tiagi (1969)
	Soaking in GA 500 ppm	Enhanced the uniformity of germination	Jouret (1977)
	Dry seeds infused with 10 mm GA_3	Gave higher germination	Persson (1993)

Common name	Treatment	Effect	Authority
Lavandula	Seed soaking in GA_3[at]100 - 200 mg/lit	Produced excellent germination	Renard and Clera (1978)
Sterlitzia reginae	Seed soaking in thiourea[at]500 ppm or Ascorbic acid 1000 ppm or ethrel 2000 ppm or incubation in oxygen at 100% and chipping the seeds in the proximal region	Improved the germination	Venter (1978)
Chrysan - themum	GA_3 soaking for 24 h at concentration of 20, 40, 60 and 80 ppm	Improved the germination to 56 – 64 per cent	Barkar (1980)
	Seed soaking in thio urea 0.5 per cent and KNO_3 0.2 per cent	Increased the germination to 31 per cent and 14 per cent thiourea and KNO_3 respectively	Guang Dong *et al.* (2000)
	Seed soaking in 1 per cent KOH for 30 minutes followed by washing for 6 h	Promoted the germination	Chiang Maehee and Park Kuenwoo (1997)
Dianthus	Seed soaking in GA_3 for 24 h at concentration of 20, 40, 60 and 80 ppm	Improved the germination to 72 – 96 per cent	Barkar (1980)
Gaillardia	Seed soaking in GA_3 for 24 h at concentrations of 20, 40, 60 and 80 ppm	Improved the germination from 64 to 86 per cent	Barkar (1980)
	Seed soaking in GA_3 200 ppm for 16 h	Improved the germination to 87 per cent than control (71 per cent)	Vijayan (2002)
Pharbitis nil	Seed soaking in 100 per cent H_2SO_4 for 40 minutes	Improved the germination to 98 per cent	Xu and Gu (1985)
Calluna vulgaris	Seeds soaking in GA_3[at]250, 300 and 500 ppm for 24, 22 and 18 days	Germination was 100 per cent in all the treatments	Grimstad (1986)

Common name	Treatment	Effect	Authority
Cyclamen persicum	Seed soaking in GA_3 5 ppm	Enhanced the germination but at higher concentration decreased the germination	Lee and Lee (1986)
	Soaking in GA_3 at 1, 3 and 5 ppm	Gave 100 per cent germination compared to 80 per cent in control	Qrunfleti (1986)
Petunia *Petunia hybrida*	Seeds soaking in GA_3 at 150 µg/ml for 15 days at 20ºC	Improved the germination to 72 per cent	Gonzalez and Villa lobos (1988)
	Cold stratification for 15 days	Improved the normal seedlings of 73 per cent	Gonzalez and Villa lobos (1991)
	Seed soaking in GA 4/7	Increased the germination per cent and reduce the mean germinated time	Finch Savage (1991)

Scotch broom *Cytisus scoparius*	Sequential rapid immersion in hot water (10 minutes) followed by liquid nitrogen (15 minutes)	Improved the imbibition and germination by 3 fold	Abdallah *et al*. (1989)
Zinnia *Zinnia elegans*	Seed soaking in 100 mg GA_3 or 100 mg $GA_{4\&7}$	Increases the germination percentage compared to control	Grezesik (1989)
	Seed soaking in NAA (5-20 mg), GA_3 (50-200 mg/lit) and $GA_{(4\&7)}$ – (50 – 200 mg lit)	Plants started to earlier flowering and were taller and better quality	Grezesik and Chojnowski (1992)
	Seed soaked in alcohol such as hexacosanol, octacosanol and triacontanol @ 0.001, 0.01 and 0.1 mg/lit	Lower concentration increased the seed germination and seedling growth was stimulated	Blamowski and Borowski (1995)
	Seed soaked in H_2O_2	Promote the seed germination	Ogawa and Iwabushi (2001)
	Seed soaked in GA_3 ppm for 16 hours	Increased the germination to 75 per cent than control (61 per cent)	Vijayan (2002)

Common name	Treatment	Effect	Authority
Cyclamen persicum	Seed soaking in GA_3 5 ppm	Enhanced the germination but at higher concentration decreased the germination	Lee and Lee (1986)
	Soaking in GA_3 at 1, 3 and 5 ppm	Gave 100 per cent germination compared to 80 per cent in control	Qrunfleti (1986)
Petunia *Petunia hybrida*	Seeds soaking in GA_3 at 150 µg/ml for 15 days at 20ºC	Improved the germination to 72 per cent	Gonzalez and Villa lobos (1988)
	Cold stratification for 15 days	Improved the normal seedlings of 73 per cent	Gonzalez and Villa lobos (1991)
	Seed soaking in GA 4/7	Increased the germination per cent and reduce the mean germinated time	Finch Savage (1991)
Scotch broom *Cytisus scoparius*	Sequential rapid immersion in hot water (10 minutes) followed by liquid nitrogen (15 minutes)	Improved the imbibition and germination by 3 fold	Abdallah *et al*. (1989)
Zinnia Zinnia elegans	Seed soaking in 100 mg GA_3 or 100 mg $GA_{4\&7}$	Increases the germination percentage compared to control	Grezesik (1989)
	Seed soaking in NAA (5 - 20 mg), GA_3 (50 - 200 mg/lit) and GA $_{(4\&7)}$ – (50 – 200 mg lit)	Plants started to earlier flowering and were taller and better quality	Grezesik and Chojnowski (1992)
	Seed soaked in alcohol such as hexacosanol, octacosanol and triacontanol[at]0.001, 0.01 and 0.1 mg/lit	Lower concentration increased the seed germination and seedling growth was stimulated	Blamowski and Borowski (1995)
	Seed soaked in H_2O_2	Promote the seed germination	Ogawa and Iwabushi (2001)
	Seed soaked in GA_3 ppm for 16 hours	Increased the germination to 75 per cent than control (61 per cent)	Vijayan (2002)
Matthiola incana	Seed soaking in 10 mg GA_3 or 100 mg $GA_{4\&7}$/lit	Improved the germination	Grezesik (1989)
	Soaking seeds in GA_3 (50 – 200 mg/lit) for 24 h	Improved the germination	Grezesik (1995)
Paeonia lactiflora	GA_3 treatment	Increased the flower buds	Evans *et al*. (1990)
Magnolia grandiflora	Soaking seeds in GA_3 1000 ppm	Highest germination percentage (70) was obtained	Misiha and El Ashry (1991)
Pantemon parryi	Soaking in GA_3 500 ppm for 24 h	Enhanced the germination to 97 per cent	Raeber and Chiwon (1991)
Snap dragon	Soaking seeds in 100 – 150 µg/ml of GA_3	Improved the germination to 85 - 90 per cent	Montero *et al*. (1992)
Coreopsis	Dry seeds infused with 10mm GA_3	Gave higher germination per cent	Persson (1993)
Ornamental sp.	Wet seed dressing of Akrygel R. P.	Gave best germination per cent	Hetman *et al*. (1996)
Pelargonium	Soaking seeds in 10.000 mg/lit of humic acid	Improved the root and shoot fresh weight and germination per cent	Hartwigsen and Evans (2000)
Lewsia hybrid	Soaking in GA_3 100 mg/lit for 24 h	Increase the germination to more than 60 per cent	Ael brecht (1989)
Phlox	Soaking seeds in GA_3 100 ppm for 8 h	Increased the germination to 90 per cent than control (60 per cent)	Sathyanarayanan (2000)
Vegetative propagation			
Ipomea fistulosa	Root dibbing of IBA 100 mg/lit	Enhanced the growth	Anand *et al*. (1972)
Bogainvillae	Dibbing in 10 or 100 ppm IBA or NAA	Increased the root formation	Mukhopadhyaya and Bose (1966)
Tulip	Bulb treatment with BA at 0.25%, NAA 0.25 and 0.5% and GA 0.5 and 2.0% and kept at 20ºC for 2 ½ months	GA_3 and NAA had adverse effect and stimulate flower stalk but delayed flowering	Saniewski *et al*. (1975)
	Ethrel 1000 ppm for 24 h	Inhibited flower stalk development	Eldabh *et al*. (1981)
	Ethrel 100 ppm for 24 h	Delayed the flowering and increased the	

		length and diameter of flower stalk	
	GA_3 1000 ppm for 24 h	Had no effect on flower stalk but increased the bulb fresh weight	
	Dipping in succinic acid[at]0.02 per cent for 30 min	Increased the yield to marketable daughter bulbs	Mugge (1988)
Begonia	GA_3 treatment on stem cuttings	Inhibit the formation of aerial tubers and increased sprouting	Okagami *et al*. (1977)
	B9 – chlorphonion or CCC to cuttings	Delayed the onset of dormancy	
Diffenbachia picta cuttings	Dipping 40 mg/lit of kinetin or 25 mg/lit of IAA	Best root development	Elshafie and Heisel (1977)
Lilac	Cuttings are soaked in NAA[at]0.8%	Produced the highest per cent of rootings	Schmidt (1977)
Gladiolus	Soaking in ethrel 100 ppm	Increased the flower size and length of flower stalk	Roychoudhuri *et al*. (1985)
	Soaking in KNO_3 2000 ppm	Enhanced the sprouting	
	Soaking in kinetin 25 ppm	Increased the plant height, leaf number and corm weight	
	Soaking corms in kinetin 25 and 50 ppm for 6 h	Increased the number of florets/spike and flower size	Nilimesh (1989)
	Dipping in Emisan[at]0.2 per cent for 10 min	Controlled the root rot	Singh and Arora (2001)
Freesia	Corms are treated with 100 ppm GA_3 at 12°C for 7 days	Advanced the flowering and increased the yield	Cocozzatalia (1985)
Achimenes	GA_3[at]50 mg/lit for 16 h and temperature treatment (21°C) for 22 weeks	Influenced the height, number of leaf whorls and flowers	Vlahos (1985)
Zantedeschia elliotriana	GA_3 500 ppm for 10 min as preplant rhizome soak	Increased the number of flower shoots and flower per shoots	Cort and Widmer (1987)
Antirrhinum	Soaking in 100 mg GA_3 or 100 mg/lit of GA_{4+7}	Increased the germination	Grezesik (1989)
	Osmo conditioned with PEG and treated with GA_3	Improved the germination	Kepezynski (1989)
Tuberose	Soaking the bulbs in GA_3[at]45 ppm for 24 h	Improved the germination percentage	Belorkar *et al*. (1993)
	Soaking in GA_3[at]200 ppm	Produced maximum number of spikes and highest number of florets per spike	Preetiharibarua *et al*. (1997)
	Bulb soaking in GA_3 500 and 1500 ppm for 24 h	Increased the flower spike length, rachis length, number of spikes per plant, and florets per spike	Nagaraja *et al*. (1999)
	Soaking the bulbs in GA_3 200 ppm	Increased the growth, flowering and bulb production	Tiwari and Singh (2002)
Foot ball lily	Soaking in GA_3 150 ppm	Earlier flowering (95.4 days) and longest flower duration (8.8 days) was obtained	Ashutoshmisha *et al*. (2000)
Rosa corymbifera	"Garetta" a commercial compost	Increased the germination to 95 per cent	Morpeth and Hall (2000)

The studies revealed that 34 different chemicals are being used for invigourating the flower seeds. Among them GA_3 occupies the wider role which has been claimed to be due to breakdown of starch and other substrates that induced the enzyme action, the first step of the germination process which created an ability to overcome a metabolic block in the embryonic axis of endosperm (Chen and Chang, 1972). Chen and Park (1973) also demonstrated that low concentration of GA_3 could stimulate amylase production in the absence of germination. But Jacobson and Zwar (1974) reported that GA_3 did not influence the synthesis of total RNA in aleurone tissue. However, Ho and Varner (1974) concluded that GA_3 promoted the synthesis of specific mRNA responsible for *in vitro* synthesis of α amylase between 5 - 8 h of GA_3 treatment. Hence this could be the reason for the enhanced germination obtained in the present study with GA_3 compared to other growth regulators. Taiz and Honigman (1976) also reported that GA_3 enhanced the activity of endo - β - 1, 4 - xylanase in the aleurone layer. The multiplicity of the effects of GA_3 in the regulation of enzyme synthesis and secretion in aleurone cells indicates that this hormone has the potential to regulate germination in numerous ways.

Wood and Paleg (1974) also demonstrated that GA_3 could modify the permeability towards glucose of modal membrane systems (liposomes) based on lecithin and that GA_3 could enter into chemical combination with phospholipids (Wood *et al*., 1974) and thus increased the germination. when GA_3 was used at higher concentration it decreased the germination significantly due to the lethal activity stimulated on enzyme reaction at supra optimal condition as reported by Chawan and Choudhri (1967) in cotton. GA_3 which was attributed to the increase in cell division and proliferation to root and apical meristem tissues by Das *et al*. (1989) and Chhipa and Lal (1988). The enhanced seed germination by GA_3 fortification was also explained to be due to a stimulation of hydrolytic enzyme activity / synthesis known to be induced by gibberellic acid as reported by Jhorar *et al*. (1982).

The better performance of IAA and IBA might be due to greater chemical stability and has low mobility in plants (Audus, 1959).

The promotion of germination in ascorbic acid is possibly due to its active participation in different metabolic reaction as an essential associate of a number of enzyme systems.

Sunyuzhen *et al.* (1996), and Gyweihong *et al.* (1997) also reported that soaking of seeds in KNO_3 responded well to this treatment and nitrate levels in the seed have been positively correlated with the level of seed germination. Addition of KNO_3 enhanced the seed germination healing the light and chilling requirement of seed (Copeland, 1988). The promotion of germination by nitrate treatment has been suggested due to conversion to nitrate within the seed (Hendricks and Taylorson, 1975). Nitrate has been proposed to induce germination by enhancing pentose phosphate pathway activity in the seed through inhibition of catalase and increased oxidation of $NADPH_2$ (Hendricks and Taylorson, 1975, and Roberts 1973). It is expressed that it is plausible to have enhanced germination due to KNO_3 which is the outcome of quantitative and qualitative shifts in protein synthesis induced by KNO_3. Dormancy sometimes imposed by paucity of oxygen caused by supraoptimal activity of the citric acid cycle which utilizes all available nitrogen. Potassium nitrate has been reported to raise the ambient oxygen level by making less oxygen available for the citric acid cycle (Bewley and Black, 1982). KNO_3 was found to counteract light inhibition and promote the germination. KNO_3 is also found to interact with temperature for promotion of seed germination.

The better performance of KH_2PO_4 and KCl might be due to influence of K that had impregnated into the seed through seed coat and had promoted quicker germination, early growth with better stamina (Srivastava and Singh, 1973) and these early vigour might had been useful for the increased energy production and use of the stored food resources for growth (Wellingford, 1980). In addition, in KH_2PO_4 the presence of P could have act as an energy carrier in biochemical reaction with K including the N uptake in plant metabolism. (Beringer, 1978). Kusnanov *et al., (*1965) and Okanenko and Bershtein (1996) reported that K improved the oxidative phosphorylation, utilization of sugar along with pentose phosphate cycle, synthesis of mitochondria and the activity of ATPase and other enzymes and these could have improved the germination capacity of seeds.

The increase in germination by KCl treatment might also be due to the action of K and Cl which acted as agents during the hydration of the seed and maintained a state of swelling which is congential for the development of plasma colloids which helps in seedling development. (Kamfer and Zehlar, 1967). Subrhamanyan and Misra (1980) reported that seed treatment with KH_2PO_4 as a compound resulted in maintenance of higher water balance in the tissue and enhanced the photosynthetic activity, and ultimately contributed to increase in establishment

Rao *et al.* (1976) reported that the NAA Increased the source activity i. e. accumulation of reducing sugar at flowering and pod developmental stage which could supply required assimilates for pod development.

The increase in germination by compost might be due to porous nature, drains well, warms readily in the sun, allows easy penetration, easily removable for repotting and should contain lower level of nitrogen and balanced levels of other nutrients (Richards *et al*., 1964).

References

[1] Bose, S. and P. Kapur, 1969. Breeding and the use of gibberellic acid to increase seed production in pansy (*Viola tricolor* L.). **Bull. Bot. Surv. India, 1 (3&4):** 445 - 447.

[2] Renard, H. A. and P. Clere.1978. Dormany breaking with gibberellins in four species, *Impatiens balsamina*, *Lavandula angustifolia*, *Brassica rapa* and *Viola odorata*. **Seed Sci. and Technol., 6** (3): 661 - 677.

[3] William, J. C.1991. Priming improves high - temperature germination to pansy seed. **Hort. Sci., 26 (5)** 541 - 544.

[4] Sharga, A. N., U. S. Motial and K. K. Basario.1970. The effect of GA_3 (Seed treatment) on the germination, vegetative growth, quantity and quality of marigold flowers. **Sci. and cult., 36**: 279 - 280.

[5] Selvaraju, P. and J. A. Selvaraj.1994. Efffect of presowing treatments on germination and vigour of seed in marigold (*Tagetes patula* L.). **Madras Agric. J., 81 (9):** 496 - 497.

[6] Hartwigsen, J. A. and M. R. Evans.2000. Humic acid and substance treatments promotes seedling root development. **Hort. Science, 35 (7):** 1231 - 1233.

[7] Djewas and Staden.1990

[8] Thompson, P. A.1970. Effect of temperature, chilling and treatment with gibberellins on the germination of primila species. **J. Hort. Sci., 45**: 175 - 85.

[9] Chavagnat, B.1981. Erude de la germination des semences de prumula obconisa. **Seed Sci. & Technol.,:** 577 - 586.

[10] Miller, E. A. and E. J. Holcomb.1982. Effect of GA_3 on germination of *Primula vulgaris* Huds. and *Primula x pulyantha*. **Hort. Sci., 17** (5): 814 - 815.

[11] Finch - Savage, W. E., D. Gary and G. M. Dickson.1991. Germination responses to seven bedding plant species to environmental condition and gibberallic acid. **Seed Sci. &Technol., 19**: 487 - 494.

[12] Heit, C. E.1971. Germination studies with geranium seed. **Proceedings of the Association of official seed Analysts, 61**: 105 - 111.

[13] Vorobeva, V. F.1977. Changes in the morphological characteristics and developmental rhythm of china asters under the influence of bacterial fertilizers. **Seed Abstr., 1** (7): 189.

[14] Serebryakova, N. V. and A. I. Kalanova.1977. The effect of water soluble vitamins on rose seed germination and rooting of cuttings. **Seed Abstr., 1** (7): 188.

[15] Renard, H. A. and P. Clera.1978. Dormany breaking with gibberellins in four species, *Impatiens balsamina*, *Lavandula angustifolia*, *Brassica rapa* and *Viola odorata*. **Seed Sci. and Technol., 6** (3): 661 - 677.

[16] Bose, S. and S. Basu.1967. Plant growth, flowering and fruiting in *Impatiens balsamina* L. Following seed treatment with diethyl sulphate. **Sci. and cult., 33**: 378 - 379.

[17] Jouret, M. F.1977. Gibberellic acid and seed dormancy breaking in *Impatiens paliflora*, *T. glanduliflora* and *T. balfourii*. **Hort. Abstr., 48** (6): 510.

[18] Persson, B.1993. Enhancement of seed germination in ornamental plants by growth regulators infused via. acetone. **Seed Sci. and Tech., 21** (2): 281 - 290.

[19] Venter, H. A.1978. Effect of various treatments on germination of dormant seeds of *Strelitizia reginae* Ait. **J. of South African Bot., 34** (2): 103 - 110.

[20] Barkar, G. J.1980. Effect of seed treatments with gibbernelic acid on germination of winter annuals. **South Indian Hort., 28** (2): 60 - 61.

[21] Xu, B. M. and Z. H. Gu.1985. Effect of sulphuric acid treatment in breaking dormancy in hard seeds. **Plant Physiology communications, 2**: 22 - 25.

[22] Hetman, J., J. Laskowska, W. Durlale and W. Martyn.1996. Preliminary studies on the possibility of utilizing acrylic gels for seed dressing of some ornamental species. **Seed Abstr., 20** (2): 486.

[23] Grimstad, S. O.1986. Effect of GA_3, temperature and storage on seed germination of beather (*Callina vulgaris*) **Hort. Abstr., 56** (2): 129.

[24] Lee, S. W. and J. M. Lee.1986. Effect of cultivar, sowing media. Seed size and gibberellin treatment on seed germination and seedling growth in Cyclamen persicum. **J. Korean society for Horticultural Science, 27** (3): 283 - 288.

[25] Gonzalez, P. and E. Villalobes.1988. Breaking seed dormancy in *Petania hybrida* with gibberellic acid and stratification treatments. **Agronomae costaricense, 12** (1): 19 - 25.

[26] Gonzalez, P. and E. Viualbos.1991. Breaking seed dormancy in petunia hybrida with GA_3 and stratification treatments. **Seed Abstr., 14** (11/12): 473.

[27] Finch - Savage, W. E., D. Gary and G. M. Dickson.1991. Germination responses to seven bedding plant species to environmental condition and gibberallic acid. **Seed Sci. &Technol., 19**: 487 - 494.

[28] Abdallah, M. M. F., R. A. Jones and A. S. El - Betagy.1989. An efficient method of overcome seeds dormancy in scotch hroom (*Cytisus scooparitus*). **Envtal and Exptal Botany, 29 (4):** 499 - 505.

[29] Grezesik, M. and M. Chojnowski.1992. Effect of growth regulators on plant growth and seed yield of *Zinnia elegans*, Red Man's. **Seed Sci & Technol., 20** (2): 327 - 330.

[30] Grezesik, M.1989. Effect of growth regulators on the seedling growth of *Lathyrus odoratus, Zinnia elagans, Matthiala incana* and *Antirrhinum majus*. **Acta Horticultura, 251**: 71 - 74.

[31] Blamowski, Z. K. and E. Borowski.1995. Effects of long chairm aliphatic alcohols on seed germination and seedlings growth of *Allium crpa* L. and *Zinnia elegans* Jacq. **Seed Abstr., 20** (8): 351.

[32] Ogawa, K. and M. Iwabushi.2001. A maturation for promoting the germination of *Zennia elegans* seeds by hydrogen peroxide. **Plant Cell and Bioassay, 42 (3):** 286 - 291.

[33] Grezesik, M.1995. Effect of growth regulators on plant growth and seed yield of Matthiola incanol Brilliant. "Barbera". **Seed Sci. & Technol., 23** (5): 801 - 806.

[34] Evans, M. R., N. A. Anderson and H. F. Wilkins.1990. Temperature and GA_3 effects on emergence and flowering of potted *Paeonia lactiflora*. **Hort. Sci., 25** (8): 923 - 924.

[35] Misiha, A. and A. El ashry.1991 Seed germination and seedling growth of *Magnolia grandiflora*. **Bulletin of faculty of Agriculture; University of Cairo, 42** (3): 869 - 879

[36] Montero, R., J. Herrera and R. Ali gaza.1992. Effect of GA_3 and prechilling on dormancy breaking in snap dragon seeds.

[37] Aelbrecht, J.1989. The effect of different treatment on the germination of *Lowsia* hybrid seeds. **Acta Horticulture, 252**: 239 - 245.

[38] Anand, V. K., R. N. Chibbar and K. K. Nanda.1972. Effects of GA_3 and IBA on rooting and on the sprouting of buds on stem cuttings of *Ipomea fistulosa*. **Plant and cell Physiology, 13** (5): 917 - 921.

[39] Mukhopadhaya, D. P. and T. K. Bose.1966. Improvement in the method of vegetative propagation in some varieties of bogainvilleas. **Indian J. Hort., 23**: 185 - 186.

[40] Eldabh, R. S., A. E. Awad and A. Nakin.1981. Effect of growth regulators on twip. **Hort. Abstr., 51** (1): 49.

[41] Saniewski, M., K. Mynett, J. Nowak and R. M. Rudnicki.1975. Studies on the effect of growth regulation on the growth and development of tulips. **Hort. Abstr., 48** (9): 742.

[42] Mugge, A.1988. Effect of succinnic acid on the vegetative propagation of tullips. **Hort. Abstr., 58** (8): 555.

[43] Okagami, N., Y. Esashi and M. Nagers.1977. Gibberelium inferred inhibition and promotion of sprouting in aerial tubers of *Begonia eransiana* Andr. In relation to photoperiodic treatment and tuber stage. **Planta, 136** (1): 1 - 6.

[44] EL - Shafie, S. A. and C. Heisel.1977. Effect of growth regulators on the rooting of *Dieffenbashia pieta* cuttings. **Hort. Abstr., 48** (7): 594.

[45] Schmidt, G.1977. Effect of α - NAA on the rooting of soft word cuttings of some lilae cultivars. **Kertgazawsag, 9** (4): 53 - 62.

[46] Roychoudhuri, N. J. Biswas, R. S. Dhua and S. K. Mitra.1985. Effect of chemicals on germination growth, flowering and corm yield of gladiolus. **Indian Agriculturist, 29** (3): 215 - 217.

[47] Cocozzatalia, M.1985. Further research about the effect to gibberellic acid upon freesia flowering. **Acta Horticulture, 167**: 187 - 191.

[48] Cort, B. E. and R. E. Widmer.1987. Gibberellic acid increases flower number in *Zantedeschia elliottina* and *Z. Rehmannii*. **Hort. Science, 22** (4): 605 - 607.

[49] Belorkar, P. U., B. N. Patil, B. S. Dhumal, U. J. Golliwar and S. D. Dalai.1993. Effect of nitrogen level and GA_3 on growth, flowering and yield of tuberose. **Journal of Soils and Crops, 3** (2): 106 - 108.

[50] Preeti Haribarua, S. Gogoi and A. Mazumder.1997. Effect of preplant chemical treatment of bulbs on growth and flowering of tuberose. cv. Single. **Annals of Biology, 13** (1): 145 - 149.

[51] Nagaraja, G. S., J. U. N. Gowda and A. A. Faroogui.1999. Effect of growth regulators on growth

and flowering of tuberose. cv. single. **Karnataka J. Agrl. Sci., 12** (1/4): 236 - 238.

[52] Tiwari, J. K. and R. P. Singh.2002. Effect of preplanting GA_3 treatments on tuberose. **J. Ornamental Hort., 5 (2):** 44 - 45.

[53] Ashutosh Misha, O. P., Chaturvedi and Rajesh Bhalla.2000. Effect of GA_3 and IAA on growth and flowering of football lily. **J. Ornamental Horticulture, 3** (1): 56 - 57.

[54] Morpeth, D. R. and A. M. Hall.2000. Microbial enhancement seed germination in *Rosa corymtifera* 'Laxa'. **Seed Sci. & Res., 19 (4):** 489 - 494.

[55] Vijayan, R.2002. Seed hardening and conditioning in zinnia and gaillardia. M. Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore

[56] Sathiyanarayanan, G.2000. Seed technological studies in phlox cv. Globe mix. M. Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore.

[57] Qrunfleti, M. M.1986. Influence of growth regulators on seed germination and seedling growth of five cyclamen hybrids. **Dirasat, 13** (5): 37 - 49.

[58] Vlahos, J. C.1985. Effect of BA and GA_3 on smoulting to Achievements rhizomes. **Acta Horticulrure, 167**: 1985.

[59] Austin, R. B., P. C. Longden, T. W. Hegarty, T. H. Thomas and R. B. Manda.1973. Pre - sowing seed treatments. **In**: Seed Biology (Ed.) W. Heydecker, Butterworths, London, pp 521 - 531.

[60] Chellapa, M, and T. V. Karivaratharaju.1973. Effect of pre - soaking treatments with phytochromes on the yield of groundnut. **Madras Agric. J., 69 (9/12):** 1462 - 1464.

[61] Begum, M, M. L. Lavania and G. H. V. Ratnababu.1997. Effect of pre - sowing treatments on seed and seedling vigour in papaya. **Seed Res., 5 (1):** 9 - 15.

[62] Chawan, A. R. and P. I. Choudhri.1967. Interaction of GA and light on the germination and growth of seedling of cotton var. Digvijay. **Indian J. Plant Physiol., 10**: 76 - 83.

[63] Chen, S. S. C. and J. L. L. Chang, 1972. **Plant Physiol., 49**: 441 - 442

[64] Chen, S. S. C. and W. M. Park.1973. **Plant Physiol., 52**: 174 - 176

[65] Chhipa, B. R. and P. Lal.1988. Effect of presoaked treatments in wheat grown on sodic soils. **Indian J. Plant Physiol., 31**: 183 - 185.

[66] *Das, S. N., S. C. Das and A. Acharya.1989. Role of growth regulators on accelerated rooting of betal vine cuttings. **Orissa J. Agric. Res., 3**: 18 - 21.

[67] Hatano, K. and S. Asakawa, 1964. Physiological process in forest tree seeds during maturation stage and germination. **International Review of Forestry Research, 1**: 279 - 323.

[68] Ho, D. T. and J. E. Varner.1974. **Proc. Natl. Acad. Sci., 71**: 4783 - 4786.

[69] Jacobson, J. V. and J. A. Zwar.1974. **Aust. J. Plant Physiol., 1**: 343 - 356.

[70] Jerlin, R., K. K. Vadivelu and P. Srimathi.1997. Effect of growth regulators on seedling attributes of acacia mellifera. **J. Tropical Forest Sci., 10 (1):** 130 - 132.

[71] Jhorar, B. S., S. K. Varma and R. P. Agarwal.1982. Effect of GA on the seedling emergence and early growth of cotton. **Indian J. Plant Physiol., 25 (4):** 423 - 426.

[72] Padmajarao, S.1979. Combined effect of phtochromes following seed treatment on yield and nutritive value in legume. **Indian J. Agric., 13 (2):** 69 - 74.

[73] Seenu, G.1987. Seed quality studies in acid lime. M. Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore.

[74] Taiz, L. and W. A. Honigman.1976. **Plant Physiol., 58**: 380 - 386.

[75] Wood, A., L, G. Paleg and T. M. Spotswood.1974. **Aust. J. Plant Physiol., 1**: 167 - 169.

[76] Wood, A. and L, G. Paleg.1974. **Aust. J. Plant Physiol., 1**: 31 - 40.