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Invivoseed germination of temperate vegetable as enhanced by germination enhancers

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Abstract

An attempt has been made to study the effect of different seed germination enhancer on seed germination behavior of different temperate vegetable seeds in invivo conditions. In case of radish, maximum seed germination percentage at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm), maximum emerging shoot length at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm), maximum emerging root length at 8th day of seed treatment could be observed in T₄ (GA₃@50ppm) and maximum seed germination vigour at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm). In case of carrot, maximum seed germination percentage at 8th day of seed treatment could be observed in T₃(GA₃ @20ppm), maximum emerging shoot length at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm), maximum emerging root length at 8th day of seed treatment could be observed in T₄ (GA₃@50ppm) and maximum seed germination vigour at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm). In case of pea, maximum seed germination percentage at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm), maximum emerging shoot length at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm), maximum emerging root length at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm), maximum seed germination vigour at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm).

Keywords: germination, invivo, temperate, germination enhancer

Introduction

Seed is botanically the mature ovule. Propagation by seeds is the most natural and traditional form of sexual reproduction in higher plants. However, seed propagation renders a high variability in F₁ generation, till then it is a major form of reproduction in majority cereal crops and vegetable crops like tomato, brinjal, pea, beans, radish, carrot, beetroot, etc. Propagation by seeds however have some constrains like poor germination percentage and poor germination vigour till then it is the seldom used method of propagation adopted by poor and marginal farmers in developing countries like India. Literature search revealed the adoption of several germination enhancing techniques using many expensive methods and skilled operations. But in context of a farmer who desires a high germination percent and good germination vigour, these methods would prove out to be economically unfeasible. So there lies a void in relation to the germination enhancement at unskilled farmer's level. The germination of seeds which have a hard testa can be significantly increased by treatment with the plant growth regulator gibberellic acid. The effect is expressed by change in proportion of inhibitors and growth regulators in favour of the last and the viable seeds germinate rapidly (Ovcharov, 1976; Jones and Stoddart, 1982; Nikolaeva, 1982) [7, 5, 6]. In recent years the method of pre-sowing treatment of seeds with gibberellic acid has been applied in industrial cultivation of banewort in Russia. This method replaces the longer process of stratification and increases crop capacity of row material by 10–20% (Geyer, 1987; Shain, 1987) [3, 8]. The aim of the present study was to trace the seed laboratory germination under the influence of different chemicals and natural seed germination enhancer. Van-Staden, 2010 have reported the role of cytokinin in enhancing seed germination of beans at a much lower concentration. Coconut water is known to enhance seed germination and sprouting of corms of *Dracontium grayumianum* (Torres *et. al.*, 2011) [10]. Shekarriz *et al.*, 2014 [9] described the role of coconut water and peptone in improving the seed germination and protocorm like body formation of hybrid Phalaenopsis. Moringa leaf extract is known to promote seed germination in maize was reported (Basra *et al.*, 2011) [2]. Gu *et al.*, 2016 [4] stated that salicylic acid in appropriate concentrations (0.2 mmol·L⁻¹) significantly improved the germination rate, germination potential and seed vigor index when incubated under high temperature stress condition (35 °C/30 °C, day/night). Anaya *et al.*, 2015 [1] also reported the positive effects of salicylic acid on seed

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germination of *Vicia faba* L. under salt stress. Zhu *et. al.*, 2005^[12] reported the effects of polyethylene glycol simulated drought stress on *Pinus sylvestris* var. mongolica seed germination on sandy land. Hence an attempt has been made to use this seed germination enhancer to enhance seed germination in these vegetable seeds under invivo conditions.

Materials and Method

Location and site

The present invivo set of experiment was conducted in the Post Graduate Laboratory, Department of Vegetable Sciences, BCKV, India. In this experiment, healthy seeds of carrot, radish and pea were collected. They were subjected to viability test using tetrazolium chloride. Only the viable seeds were collected and were studied for seed germination aspects. Then the seeds were treated with carbendazim @2% to ensure no seed borne disease. Then the seeds were subjected to different treatments. The entire germination study was conducted in natural day-night light cycle. It was ensured that the seeds were sufficiently moist. The cushioning tissue papers helped to keep the seeds moist.

Seed treatment

20 seeds were arranged in each petri-dish and were properly cushioned with moist blotting paper. Each treatment had 3 replications. Hence, there were 60 seeds studied per treatment. There were 8 replications including control. The different treatments were, T₁ - Control, T₂ - Cytokinin @100ppm, T₃ - GA₃ @20ppm, T₄ - GA₃ @50ppm, T₅ - Coconut water @5%, T₆ - Moringa leaf extract @2%, T₇ - Salicylic acid @1%, T₈ - Polyethylene glycol @2%. These treatments were applied to the seeds by the help of a dropper.

Observations recorded

The following observations were recorded after the seeds were treated and placed in the petridish:

- Seed germination percent (%)**: Seed germination percent was determined by observing the number of seeds that germinate at the given days of observation.
- Shoot length (cm) and Root length (cm)**: Developing shoot and root length was measured by using digital vernier calipers.
- Germination vigour**: Germination vigour of the seeds were determined by using the formula

$$\text{Germination vigour} = \frac{\text{Germination percentage} \times (\text{Shoot length} + \text{Root length})}{2}$$

Results and Discussion

Seed germination percentage (%)

Table 1 shows the seed germination percentage of different temperate vegetables seeds under influence of different seed germination enhancer. In case of radish, maximum seed germination percentage at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm) which was 99% followed by T₈ (Polyethylene glycol @2%) which was 95.33%, T₇ (Salicylic acid @1%) which was 94% and T₅ (Coconut water @5%) which was 93.67%. Minimum germination percent was observed in T₁ (control) which was 70%. In case of carrot, maximum seed germination percentage at 8th day of seed treatment could be observed in T₃(GA₃ @20ppm) which was 97% followed by T₇(Salicylic acid@1%) which was 92.33%, T₄(GA₃ @50ppm) which was 92% and T₅ (Coconut water @5%) which was 90%. Minimum germination percent was observed in T₁ (control) which was 65.67%. In case of pea, maximum seed germination percentage at 8th day of seed

treatment could be observed in T₄ (GA₃ @50ppm) which was 97% followed by T₃(GA₃ @20ppm) which was 91.33% and T₅ (coconut water @5%) which was 89%. Minimum germination percent was observed in T₁ (control) which was 60.67%. This shows that seed germination enhancer have significant role in promoting germination of the seeds present.

Emerging shoot length (cm)

Table 2 shows emerging shoot length (cm) of different temperate vegetables seeds under influence of different seed germination enhancer. In case of radish, maximum emerging shoot length at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm) which was 15.40cm followed by T₅ (coconut water @5%) which was 11.34% and T₁ (control) which was 11.20cm. Minimum emerging shoot length was observed in T₇ (Salicylic acid @1%) and T₈ (Polyethylene glycol @2%) which was 1.32 cm and 1.42 cm respectively. In case of carrot, maximum emerging shoot length at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm) which was 23.70cm followed by T₅ (Coconut water @5%) which was 15.89 and T₈ (Polyethylene glycol @2%) which was 13.98cm. Minimum emerging shoot length was observed in T₇ and T₈ which was 1.42 cm and 1.69 cm respectively. In case of pea, maximum emerging shoot length at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm) which was 23.18 cm followed by T₅ (coconut water @5%) which was 19.26 cm, T₃ (GA₃ @20%) which was 18.46 cm and T₈ (Polyethylene glycol @2%) which was 18.29 cm. Minimum emerging shoot length was observed in T₁ (Control) which was 4.29 cm. This shows that GA₃ @ 50ppm and GA₃ @20ppm is having excellent quality in enhancing developing shoot length. T₅ (Coconut water @5%) and T₈ (Polyethylene glycol @2%) also have a positive role in developing the shoot length of germinating seeds.

Emerging root length (cm)

Table 3 shows emerging root length (cm) of different temperate vegetables seeds under influence of different seed germination enhancer. In case of radish, maximum emerging root length at 8th day of seed treatment could be observed in T₄ (GA₃@50ppm) which was 12.20cm followed by T₅ (coconut water @5%) which was 11.10 cm and T₇ (Salicylic acid @1%) which was 10.90cm. Minimum emerging root length was observed in T₁ (control) which was 1.22 cm. In case of carrot, maximum emerging root length at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm) which was 10.46 cm followed by T₅ (Coconut water @5%) which was 10.06 cm and T₈ (Polyethylene glycol @2%) which was 9.93 cm. Minimum emerging root length was observed in T₁ (control) which was 1.26 cm. In case of pea, maximum emerging root length at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm) which was 18.94 cm followed by T₇ (Coconut water @5%) which was 14.49cm. T₈ (13.97cm), T₅ (13.49cm) and T₂ (13.26cm) also have a considerable root length. Minimum emerging root length was observed in T₁ (Control) which was 3.94cm. This shows that GA₃ @50ppm and GA₃ @20ppm is again proved to have excellent quality in enhancing developing root length.

Seed germination vigour

Table 4 shows the seed germination vigour of temperate vegetable seeds under influence of different seed germination enhancer. In case of radish, maximum seed germination vigour at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm) which was 2733.19 followed by T₅ (coconut

water @5%) which was 2101.91 and T₈ (Polyethylene glycol @2%) which was 1754.84. A very high seed germination vigour was also observed in T₃ (GA₃ @20ppm) which was 1610.75 and T₇ (Salicylic acid @1%). Minimum seed germination vigour was observed in T₁ (control) which was 238.93. In case of carrot, maximum emerging root length at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm) which was 3157.81 followed by T₅ (Coconut water @5%) which was 2335.22 and T₈ (Polyethylene glycol @2%) which was 2047.47. Minimum emerging root length was observed in T₁ (Control) which was 246.84. In case of pea,

maximum seed germination vigour at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm) which was 4084.61 followed by T₅ (Coconut water @5%) which was 2915.17. T₃ (2869.23), T₈ (2396.60) and T₂ (2138.34). Minimum seed germination vigour was observed in T₁ (Control) which was 664.06. This shows that GA₃ @50ppm and GA₃ @20ppm is again proved to have excellent quality in enhancing seed germination vigour. Beside that Polyethylene glycol @2%, Cytokinin @100ppm and Coconut water @5% also have a high seed germination vigour.

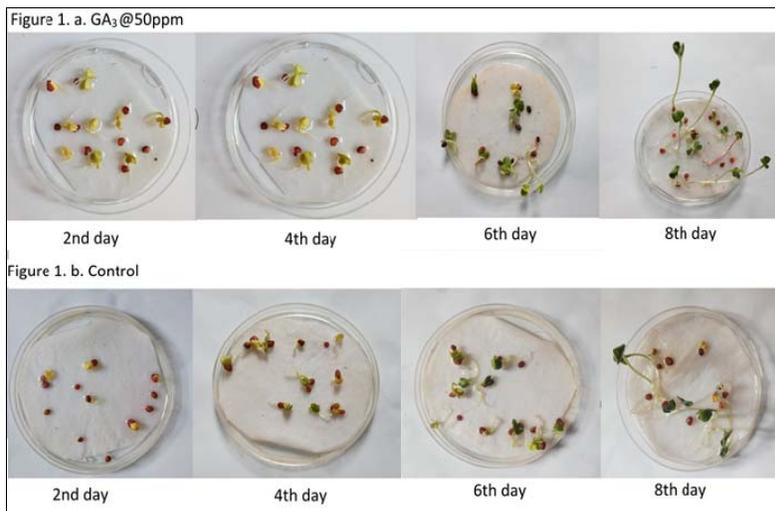


Fig 1: Effect of treatment on seed germination behavior of radish

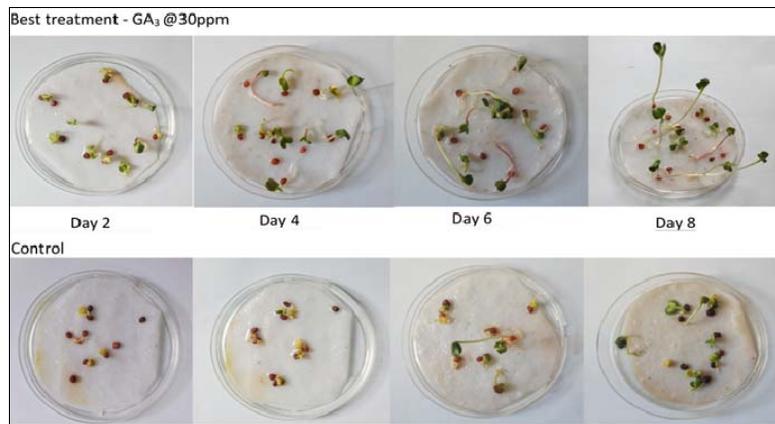


Fig 2: Effect of treatment on seed germination behavior of carrot

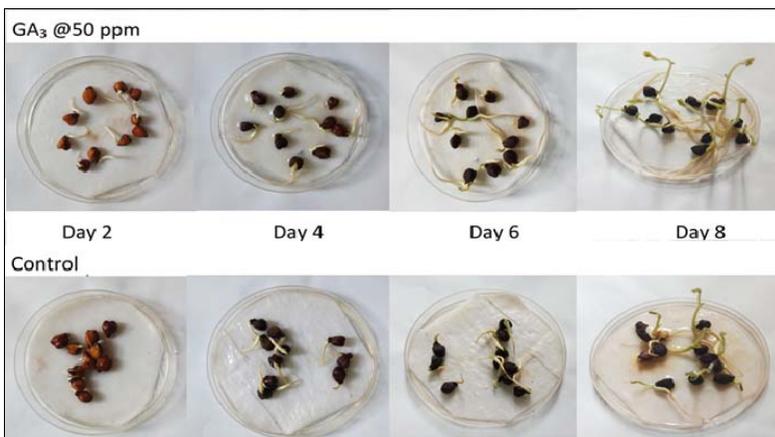


Fig 3: Effect of treatment on seed germination behavior of pea

Table 1: Seed germination percentage (%) of temperate vegetable seeds under influence of different seed germination enhancer

Treatments	Days	Crops											
		Radish				Carrot				Pea			
		2 nd	4 th	6 th	8 th	2 nd	4 th	6 th	8 th	2 nd	4 th	6 th	8 th
T ₁ – Control		39.00	44.00	52.00	70.00	40.00	45.67	54.67	65.67	34.67	40.67	49.67	60.67
T ₂ – Cytokinin @100ppm		59.33	66.33	74.33	89.33	59.33	72.33	78.67	84.67	51.67	56.67	65.67	74.67
T ₃ - GA ₃ @20ppm		62.00	69.00	78.00	91.00	64.33	89.00	94.33	97.00	70.33	73.33	81.33	91.33
T ₄ - GA ₃ @50ppm		77.67	87.67	97.67	99.00	77.00	85.00	91.33	92.00	75.67	85.33	94.33	97.00
T ₅ - Coconut water @5%		73.67	81.67	89.67	93.67	70.33	80.33	87.00	90.00	66.00	73.00	83.00	89.00
T ₆ - Moringa leaf extract @2%		59.67	65.67	72.67	86.67	58.33	70.33	79.67	84.67	67.33	74.33	82.33	85.33
T ₇ - Salicylic acid @1%		76.00	84.00	92.00	94.00	68.67	79.67	89.33	92.33	55.67	65.67	75.67	80.67
T ₈ - Polyethylene glycol @2%		73.33	79.33	87.33	95.33	72.00	81.00	83.67	85.67	47.33	58.33	68.33	74.33
SE(m)		2.02	2.02	2.01	2.20	40.00	2.04	2.29	2.19	1.86	1.94	1.85	1.74
C.D.		6.10	6.10	6.20	6.66	59.33	6.16	6.94	6.61	5.64	5.94	5.60	5.27

Table 2: Emerging shoot length (cm) of temperate vegetable seeds under influence of different seed germination enhancer

Treatments	Days	Crops											
		Radish				Carrot				Pea			
		2 nd	4 th	6 th	8 th	2 nd	4 th	6 th	8 th	2 nd	4 th	6 th	8 th
T ₁ – Control		1.20	1.33	1.28	1.32	1.23	1.33	1.42	1.42	1.24	2.56	3.56	4.29
T ₂ – Cytokinin @100ppm		2.43	5.53	6.40	7.80	2.31	5.09	8.96	10.48	2.56	4.65	9.15	15.37
T ₃ - GA ₃ @20ppm		3.40	6.67	7.10	8.50	3.12	6.12	9.51	12.28	2.75	5.58	11.25	18.46
T ₄ - GA ₃ @50ppm		3.97	10.73	12.80	15.40	4.33	10.33	18.56	23.70	4.26	9.46	18.60	23.18
T ₅ - Coconut water @5%		3.37	8.43	9.40	11.34	3.35	8.94	12.32	15.89	3.94	8.12	15.26	19.26
T ₆ - Moringa leaf extract @2%		1.31	1.40	1.39	1.42	1.65	1.68	1.69	1.69	1.59	2.98	4.51	5.16
T ₇ - Salicylic acid @1%		3.03	7.83	9.50	11.20	2.90	6.23	10.35	13.31	3.12	7.25	13.45	16.49
T ₈ - Polyethylene glycol @2%		2.90	4.60	7.34	9.50	3.94	9.72	11.59	13.98	3.56	7.89	14.92	18.29
SE(m)		0.14	0.15	0.13	0.16	0.05	0.10	0.18	0.23	0.05	0.11	0.20	0.26
C.D.		0.44	0.44	0.39	0.47	0.14	0.32	0.54	0.70	0.15	0.32	0.61	0.79

Table 3: Emerging root length (cm) of temperate vegetable seeds under influence of different seed germination enhancer

Treatments	Days	Crops											
		Radish				Carrot				Pea			
		2 nd	4 th	6 th	8 th	2 nd	4 th	6 th	8 th	2 nd	4 th	6 th	8 th
T ₁ – Control		1.14	1.10	1.12	1.22	1.12	1.23	1.26	1.26	1.22	1.98	3.26	3.94
T ₂ – Cytokinin @100ppm		2.23	5.80	6.60	7.51	2.19	4.95	6.34	7.23	2.11	4.12	8.25	13.26
T ₃ - GA ₃ @20ppm		3.17	5.60	6.90	9.20	3.05	5.23	7.56	8.46	2.05	5.25	9.46	12.95
T ₄ - GA ₃ @50ppm		3.53	9.71	11.60	12.20	6.23	7.94	9.94	10.64	3.91	8.89	15.49	18.94
T ₅ - Coconut water @5%		3.07	7.41	9.10	11.10	4.11	6.58	8.69	10.06	3.09	7.25	12.49	13.49
T ₆ - Moringa leaf extract @2%		1.20	1.23	1.22	1.25	1.43	1.54	1.56	1.56	1.36	1.56	3.46	4.12
T ₇ - Salicylic acid @1%		2.67	7.50	9.20	10.90	2.63	6.13	7.85	8.65	2.98	6.56	12.26	14.49
T ₈ - Polyethylene glycol @2%		2.60	4.20	6.10	8.90	3.42	6.51	8.91	9.93	3.07	6.54	10.28	13.97
SE(m)		0.16	0.19	0.12	0.13	0.09	0.09	0.11	0.13	0.04	0.10	0.17	0.21
C.D.		0.48	0.59	0.38	0.39	0.26	0.27	0.33	0.40	0.13	0.29	0.51	0.64

Table 4: Seed germination vigour of temperate vegetable seeds under influence of different seed germination enhancer

Treatments	Days	Crops											
		Radish				Carrot				Pea			
		2 nd	4 th	6 th	8 th	2 nd	4 th	6 th	8 th	2 nd	4 th	6 th	8 th
T ₁ – Control		177.89	204.13	220.72	238.93	161.37	203.95	238.81	246.84	136.99	298.23	516.19	664.06
T ₂ – Cytokinin @100ppm		278.43	752.61	966.37	1367.72	266.82	726.41	1203.79	1499.67	241.52	497.17	1142.98	2138.34
T ₃ - GA ₃ @20ppm		408.00	846.57	1092.03	1610.75	396.91	1010.07	1610.60	2011.93	337.53	794.47	1684.91	2869.23
T ₄ - GA ₃ @50ppm		582.67	1790.20	2383.46	2733.19	812.72	1552.41	2601.73	3157.81	618.90	1567.35	3219.14	4084.61
T ₅ - Coconut water @5%		475.20	1294.02	1658.87	2101.91	524.44	1246.75	1827.88	2335.22	463.78	1122.31	2303.36	2915.17
T ₆ - Moringa leaf extract @2%		149.49	172.50	189.74	231.20	179.73	226.53	258.98	980.95	198.61	337.44	656.14	791.55
T ₇ - Salicylic acid @1%		223.53	675.34	973.47	1548.07	221.53	565.23	995.63	1442.79	211.46	561.81	1277.06	1879.61
T ₈ - Polyethylene glycol @2%		403.52	698.42	1174.31	1754.84	529.98	1314.71	1714.56	2047.47	313.48	840.81	1720.73	2396.60
SE(m)		25.50	33.82	43.08	52.27	13.57	23.78	35.13	32.68	13.51	33.93	65.65	63.47
C.D.		77.11	102.25	130.27	158.06	41.03	71.90	106.23	98.81	40.85	102.61	198.51	191.97

Summary and conclusion

In case of radish, maximum seed germination percentage at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm), maximum emerging shoot length at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm), maximum emerging root length at 8th day of seed treatment could be

observed in T₄ (GA₃@50ppm) and maximum seed germination vigour at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm). In case of carrot, maximum seed germination percentage at 8th day of seed treatment could be observed in T₃ (GA₃ @20ppm), maximum emerging shoot length at 8th day of seed treatment could be observed in T₄

(GA₃ @50ppm), maximum emerging root length at 8th day of seed treatment could be observed in T₄ (GA₃@50ppm) and maximum seed germination vigour at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm). In case of pea, maximum seed germination percentage at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm), maximum emerging shoot length at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm), maximum emerging root length at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm), maximum seed germination vigour at 8th day of seed treatment could be observed in T₄ (GA₃ @50ppm).

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