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RESEARCH ARTICLE

Effect of NAA, triacontanol and boron on initial seed quality and storability of bitter gourd (*Momordica charantia*) cv. PUSA VISESH

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SUMMARY

The field experiment was conducted during *Rabi* season of the year 2009 at College of Agriculture, Raichur, in order to find out the response of NAA, triacontanol and boron on seed quality and storability in bitter gourd cv. PUSA VISESH. The experiment was laid out in randomized block design considering eight treatments *viz*., NAA (25 and 50 ppm), triacontanol (0.5 and 1.0 ppm), boron (3.0 and 4.0 ppm), water spray and absolute control. Results revealed that NAA 50 ppm recorded highest initial seed germination and lowest electrical conductivity. Whereas, boron at 4 ppm recorded highest seedling length, seedlings dry weight and dehydrogenase enzyme activity. Resultant seeds stored in cloth bags under ambient storage condition and seed quality tested after every month end of storage period (February, 2010 – January, 2011). The storage study revealed that boron at 4 ppm maintained highest seed quality parameters like seed germination, seedling length, seedling dry weight, speed of germination, dehydrogenase activity and lowest electrical conductivity at the end of twelve months storage period.

Key Words : Bitter gourd, Seed quality, Cloth bag, Storage

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Bitter gourd (*Momordica charantia* L.) is one of the most important tropical vegetable crops. It belongs to the family cucurbitaceae and popularly known as balsom pear, karela, or bitter melon.

The plant growth regulators (PGR's) are considered as a new generation agrochemicals after fertilizers, pesticides and herbicides. In bitter gourd, it is possible to increase the yield by increasing the fruit set by using growth regulators. Use of PGR's and micro nutrient like boron might be a useful alternative to increase crop production. GA_3 and NAA are also important growth regulators that may have ability to modify the growth, sex ratios and yield contributing characters of plant (Shantappa *et al.,* 2007).

The micronutrient and cations are involved in enzyme systems as cofactors with the exception of Zn, Mn, Cu and B. These are capable of acting as 'electron carriers' in the enzyme systems and are responsible for the oxidative-reduction process in the plant system. In the present study efforts were made to know the effect of plant growth regulators (NAA and Triacontanol) and chemical (B) on seed yield and quality of bitter gourd (*Momordica charantia*) cv. PUSA VISESH.

Storage and preservation of quality seed stocks till the next season is as important as producing quality seeds. Farmers and scientists opined that safe storage of seeds is advantages as it reduces the burden of seed production every year, besides timely supplying of desired genetic stocks for the use in years following periods of low production. The germination and vigour which can be expected from stored seeds is another

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matter of great importance.

Seed is said to be in storage on plant itself right from its physiological maturity and it continues to be in storage until next sowing or further use or death. Deterioration of seed during storage is inevitable and leads to different changes at different levels *viz.*, impairment or shift in metabolic activity, compositional changes, decline or change in enzyme activities, phenotypic, cytological changes apart from quantitative losses. Being hygroscopic in nature the viability and vigour of seeds under storage are known to be regulated by variations in the physico-chemical factors, initial seed quality, storage structures, packaging materials etc. (Doijode, 1988). A knowledge of proper storage of seeds under ambient conditions at relatively low cost with minimum deterioration in quality for a period of at least one or more seasons will be of immense use to seed industry and farming community.

MATERIALS AND METHODS

A field experiment was conducted at College of Agriculture, Raichur, Karnataka during *Rabi* 2009 with three replications in Randomized Block Design. The healthy and bold seeds were dibbled with a spacing of 120 cm x 80 cm to a depth of 4.0 cm. After germination one seedling per hill was maintained. The gross plot size of the plot was 10.80m x 8.0 m = 86.4 m^2 and net plot size: 8.4 m x 6.4 m = 76.8 m^2. The plant protection measures were adopted as and when required. Two growth regulators *viz.,* NAA (25 and 50 ppm), triacontanol (0.5 and 1.0 ppm) and boron (3.0 and 4.0 ppm) were used for foliar application at two concentrations with absolute control and water spray at two to four true leaf stage and then at 60 days after sowing (DAS), 75 DAS and 90 DAS. Precaution was taken to prevent drifting of spray solution from one treatment plot to other. In each treatment five plants were randomly selected and tagged for recording various biometric observations as detailed below. Fruits were harvested as when they turn orange red colour and seeds were harvested manually. Seed germination percentage, seedling length, seedling dry weight, speed of germination, electrical conductivity and dehydrogenase enzyme activity were recorded immediately after harvest and subsequently at monthly intervals (Feb. 10 – January 2011). The germination test, electrical conductivity and dehydrogenase enzyme activity was conducted as per ISTA (International Seed Testing Association) procedure by rolled towel method. From the germination test, ten normal seedlings were selected randomly from each treatment on the day of final count. The seedling length was measured from shoot tip to root tip. Ten normal seedlings were taken in butter paper and dried in a hot-air oven maintained at 90^0C for 24 hours used for measuring seedling dry weight, later seedlings were removed and allowed to cool in a desiccators for 30 minutes before weighing in an electronic balance.

Seeds were germinated in germination paper medium with four replications of 100 seed each. The numbers of seeds germinated were recorded daily up to the day of final count. Cotyledon slipping out of the seed coat was taken as criteria for emergence of seedling and the speed of germination was calculated by using the formula suggested by Agrawal (1995).

$$\text{Speed of germination} = \frac{X_1}{Y_1} + \frac{X_2 - X_1}{Y_1} + \text{-------} + \frac{X_n(X_n - 1)}{Y_n}$$

where,

X_n : % germination on n^{th} day

Y_n : Number of days from seed sowing

RESULTS AND DISCUSSION

Seed is the nucleus of life and is subjected to continuous ageing once it has reached physiological maturity. This phenomenon results in an irreversible change in seed quality ultimately affecting viability. The quantitative deterioration during storage is mainly attributed to period of storage.

In the present study the growth regulators and chemical had a significant effect on germination. Boron treatment showed significantly higher germination throughout the storage period followed by NAA and triacontanol which were at par with each other.

After the harvest of the crop, the resultant seeds were analyzed for various seed quality parameters (Table 1). Growth

Table 1: Effect of NAA, triacontanol and boron on initial seed quality in bitter gourd cv. PUSA VISESH

Treatments	Germination (%)	Seedling length (cm)	Seedling dry weight (mg)	Electric conductivity (dSm^{-1})	Dehydrogenase activity (OD values)
T_1 : Absolute control	79.50 (63.09)	16.79	109.00	0.342	0.275
T_2 : Water spray	80.25 (63.63)	17.79	112.25	0.336	0.282
T_3 : Naphthalene acetic acid @ 25 ppm	82.75 (65.47)	19.93	123.78	0.329	0.291
T_4 : Naphthalene acetic acid @ 50 ppm	83.25 (65.84)	21.11	127.65	0.316	0.333
T_5 : Triacontanol @ 0.5 ppm	80.00 (63.46)	19.55	118.95	0.337	0.324
T_6 : Triacontanol @ 1.0 ppm	80.75 (63.98)	19.80	119.75	0.332	0.326
T_7 : Boron @ 3.0 ppm	82.50 (65.28)	19.67	124.98	0.334	0.331
T_8 : Boron @ 4.0 ppm	83.00 (65.65)	21.16	129.51	0.323	0.352
S.E.±	0.68	0.38	1.19	0.001	0.281
C.D. (P=0.05)	2.00	1.12	3.46	0.004	0.289

Table 2 : Effect of plant growth regulators and chemical on seed germination (%) of bitter gourd cv. PUSA VISESH during storage

Treatments	Storage period (month)											
	1	2	3	4	5	6	7	8	9	10	11	12
T_1 : Absolute control	81.75	83.25	83.75	82.75	81.25	80.00	79.25	78.50	77.75	76.50	75.75	74.50
	(64.73)	(65.85)	(66.25)	(65.53)	(64.36)	(63.45)	(62.94)	(62.42)	(61.88)	(61.04)	(60.52)	(59.69)
T_2 : Water spray	82.25	84.50	85.50	84.75	83.50	82.25	81.75	81.00	79.75	78.25	77.00	75.75
	(65.09)	(66.87)	(67.69)	(67.09)	(66.11)	(65.15)	(64.75)	(64.26)	(63.47)	(62.23)	(61.40)	(60.54)
T_3 : Naphthalene acetic acid @25 ppm	86.25	88.00	88.75	88.50	88.00	87.25	86.75	86.25	86.00	85.25	84.50	83.75
	(68.26)	(69.81)	(70.41)	(70.34)	(69.79)	(69.24)	(68.75)	(68.37)	(68.08)	(67.42)	(67.16)	(66.51)
T_4 : Naphthalene acetic acid @ 50 ppm	87.75	89.25	90.25	90.25	90.25	89.00	88.50	88.00	87.25	87.00	86.25	85.25
	(69.57)	(70.93)	(71.84)	(71.83)	(71.88)	(70.75)	(70.26)	(69.79)	(69.13)	(69.08)	(68.26)	(67.44)
T_5 : Triacontanol @ 0.5 ppm	84.00	87.00	87.50	87.25	87.25	86.75	86.50	86.50	86.00	85.50	84.75	83.75
	(66.45)	(68.90)	(69.33)	(69.10)	(69.10)	(68.79)	(68.59)	(68.55)	(68.03)	(67.69)	(67.03)	(66.24)
T_6 : Triacontanol @ 1.0 ppm	85.00	87.25	88.00	87.75	87.50	86.75	86.75	86.50	86.50	86.00	85.50	84.50
	(67.22)	(69.13)	(69.75)	(69.59)	(69.33)	(68.70)	(68.68)	(68.46)	(68.45)	(68.15)	(67.84)	(67.01)
T_7 : Boron @ 3.0 ppm	86.75	87.25	89.25	89.00	88.75	88.25	88.00	87.75	87.25	86.50	86.00	85.00
	(68.67)	(69.10)	(70.88)	(70.69)	(70.47)	(70.03)	(69.81)	(69.59)	(69.09)	(68.49)	(68.08)	(67.26)
T_8 : Boron @4.0 ppm	88.50	90.25	91.00	90.50	90.25	89.25	89.00	88.75	87.50	87.00	86.50	85.50
	(70.22)	(71.84)	(72.61)	(72.18)	(71.94)	(70.93)	(70.78)	(70.59)	(69.37)	(69.01)	(68.48)	(67.65)
S.E.	0.68	0.88	0.74	1.14	0.98	1.15	1.18	1.29	1.09	1.28	1.39	1.31
C.D. (P=0.05)	1.99	2.56	2.16	3.32	2.86	3.35	3.46	3.76	3.18	3.74	4.05	3.83

Figures in the parenthesis indicate angular transformed values

regulators and nutrient sprayed treatments showed beneficial significant influence on seed quality parameters over control.

The seeds harvested from the plant received NAA 50 ppm showed higher germination (83.25 %) and lowest electrical conductivity (0.316 dSm^{-1}) which was at par with boron 4 ppm (83.00 % and 0.323 dSm^{-1}, respectively) while; control recorded lowest (79.50 % and 0.342 dSm^{-1}, respectively). This increase in seed quality due to spray of growth regulators might be due to adequate supply of food reserves to resume embryo growth and synthesis of hydrolytic enzymes which are secreted and act on starchy endosperm in turn affecting physiology of seed germination and establishment of seedling. Similar effect of NAA on seed germination was also earlier reported by Shantappa *et al.* (2007) in bitter gourd.

The low seed germination percentage recorded in freshly harvested seeds might be due to the primary dormancy associated with embryo of fresh seeds. Later on as storage proceeds there was gradual increase in seed germination in all the treatments up to third month after storage. From fourth month onwards there was a slightly decrease in seed germination and seed quality parameters indicating the on-set of deterioration which might be due to the combined effects of high temperature, low oxygen, and high CO_2 partial pressures (Edelstein *et al.,* 1995) in melon.

Boron 4 ppm treatment revealed highest seedling length, seedling dry weight and dehydrogenase enzyme activity (21.16 cm, 129.51 mg and 0.352 OD value, respectively) which were at par with NAA at 50 ppm (21.21 cm, 127.65 mg and 0.333 OD value, respectively) whereas, seedling length, seedling dry weight and lowest dehydrogenase enzyme activity (16.79 cm, 109.00 mg and 0.275 OD value, respectively) recorded in control (Table 3, 4 and 6). This might be due to adequate supply of food reserves to resume embryo growth and in addition to release enzymes responsible for degradation of macromolecules into micromolecules to be utilized in growth promoting processes (Gedam *et al.*, 1996) in bitter gourd.

The storage study revealed that the germination percentage (Table 2). was significantly highest in boron @ 4 ppm (88.50 %, 91.00 % and 85.50 %) followed by NAA @ 50 ppm (87.75 %, 89.25 % and 85.25 %), boron @ 3 ppm (86.75 %, 89.25 % and 85.00 %) and water spray (82.25 %, 85.50 % and 75.75 %) whereas, lowest germination percentage was observed in absolute control (81.75 %, 82.75 % and 74.50 % , respectively) at the end of first, third and twelve month of storage period, respectively. Highest germination percentage at the end of third month of storage period might be due to the natural breakdown of seed dormancy due to external environmental factors. It might

Table 3 : Effect of plant growth regulators and chemical on seedling length (cm) of bitter gourd cv. PUSA VISESH during storage

Treatments	Storage period (month)											
	1	2	3	4	5	6	7	8	9	10	11	12
T_1 : Absolute control	17.40	17.69	18.07	18.04	17.87	17.71	17.56	17.49	17.44	17.10	16.55	16.23
T_2 : Water spray	18.26	18.38	18.85	18.82	18.63	18.53	18.43	18.33	18.21	17.92	17.18	16.94
T_3 : Naphthalene acetic acid @25 ppm	19.97	20.32	20.91	20.88	20.79	20.69	20.63	20.62	20.58	20.59	20.42	20.19
T_4 : Naphthalene acetic acid @ 50 ppm	21.15	21.77	22.58	22.55	22.43	22.32	22.11	22.02	22.00	21.81	21.60	21.31
T_5 : Triacontanol @ 0.5 ppm	19.55	19.93	20.76	20.73	20.63	20.55	20.46	20.40	20.21	20.11	19.91	19.76
T_6 : Triacontanol @ 1.0 ppm	19.70	20.12	21.04	20.99	20.83	20.73	20.67	20.65	20.57	20.47	20.18	20.07
T_7 : Boron @ 3.0 ppm	19.94	20.49	21.12	21.09	20.96	20.94	20.84	20.81	20.68	20.51	20.36	20.30
T_8 : Boron @4.0 ppm	21.27	21.64	22.49	22.47	22.41	22.38	22.28	22.09	22.03	21.94	21.72	21.60
S.E.±	0.33	0.35	0.31	0.38	0.35	0.32	0.39	0.42	0.40	0.34	0.36	0.36
C.D. (P=0.05)	0.96	1.02	0.92	1.10	1.03	0.92	1.14	1.22	1.16	0.98	1.06	1.05

Table 4: Effect of plant growth regulators and chemical on seedling dry weight (mg) of bitter gourd cv. PUSA VISESH during storage

Treatments	Storage period (month)											
	1	2	3	4	5	6	7	8	9	10	11	12
T_1 : Absolute control	108.50	108.70	108.77	108.75	108.74	108.74	108.71	108.69	108.68	108.66	108.64	108.63
T_2 : Water spray	112.35	112.37	112.44	112.45	112.43	112.42	112.42	112.41	112.39	112.38	112.38	112.35
T_3 : Naphthalene acetic acid @25 ppm	123.53	123.98	125.40	125.40	125.38	125.31	125.24	125.12	125.08	125.02	124.92	124.88
T_4 : Naphthalene acetic acid @ 50 ppm	124.40	124.94	125.40	125.40	125.40	125.40	125.39	125.39	125.38	125.38	125.38	125.37
T_5 : Triacontanol @ 0.5 ppm	118.70	119.15	119.24	119.24	119.24	119.24	119.23	119.23	119.23	119.23	119.23	119.23
T_6 : Triacontanol @ 1.0 ppm	119.70	120.18	120.18	120.18	120.18	120.18	120.17	120.17	120.15	120.15	120.13	120.12
T_7 : Boron @ 3.0 ppm	124.73	125.18	125.21	125.21	125.20	125.18	125.18	125.17	125.16	125.16	125.16	125.15
T_8 : Boron @4.0 ppm	129.26	129.74	130.26	130.26	130.26	130.26	130.25	130.25	130.25	130.24	130.24	130.23
S.E.±	0.61	0.62	0.60	0.60	0.62	0.62	0.61	0.61	0.61	0.61	0.60	0.60
C.D. (P=0.05)	1.78	1.81	1.75	1.75	1.80	1.80	1.77	1.77	1.75	1.77	1.76	1.76

Table 5 : Effect of plant growth regulators and chemical on speed of germination of bitter gourd cv. PUSA VISESH during storage

Treatments	Storage period (month)											
	1	2	3	4	5	6	7	8	9	10	11	12
T_1 : Absolute control	15.94	15.89	16.04	15.93	15.90	15.86	15.69	15.67	15.47	15.35	15.31	14.71
T_2 : Water spray	16.73	16.84	16.73	16.57	16.52	16.48	16.31	16.25	15.99	15.82	15.76	15.55
T_3 : Naphthalene acetic acid @25 ppm	17.36	17.59	17.73	17.51	17.46	17.41	17.31	17.15	16.77	16.67	16.50	16.43
T_4 : Naphthalene acetic acid @ 50 ppm	18.91	18.95	19.11	18.93	18.85	18.64	18.63	18.46	18.40	18.33	18.27	18.17
T_5 : Triacontanol @ 0.5 ppm	16.49	16.59	16.60	16.56	16.38	16.28	16.23	16.17	16.01	15.87	15.83	15.73
T_6 : Triacontanol @ 1.0 ppm	17.70	17.79	17.97	17.91	17.91	17.78	17.68	17.61	17.41	17.20	17.13	17.03
T_7 : Boron @ 3.0 ppm	18.84	18.70	19.10	18.82	18.82	18.72	18.63	18.50	18.43	18.37	18.33	18.20
T_8 : Boron @4.0 ppm	19.17	19.08	19.49	19.17	19.17	18.96	18.76	18.68	18.56	18.43	18.36	18.23
S.E.±	0.34	0.29	0.36	0.37	0.55	0.55	0.57	0.52	0.59	0.55	0.56	0.61
C.D. (P=0.05)	0.98	0.83	1.07	1.12	1.64	1.66	1.71	1.55	1.75	1.66	1.68	1.83

be due to adequate supply of food reserves to resume embryo growth and synthesis of hydrolytic enzymes which are secreted and act on starchy endosperm in turn affecting physiology of seed germination and establishment of seedling. Effect of boron on seed germination was also earlier reported by Gedam *et al.* (1996) in bitter gourd, these differences in storability might be due to variations in their effectiveness in combating the seed borne pathogen.

The speed of germination (19.17, 19.49 and 18.23 numbers) were significantly higher in boron at 4 ppm and was at par with NAA at 50 ppm (18.91, 19.11 and 18.17) whereas, lowest was recorded in absolute control (15.94, 16.04 and 14.71) at the end of first, third and twelve month of storage period, respectively.

Dehydrogenase enzyme activity (0.350, 0.431 and 0.359 OD value significantly maximum in boron at 4 ppm and was at par with NAA at 50 ppm (0.330, 0.400 and 0.348 OD value, respectively), whereas lowest was recorded in absolute control (0.272, 0.311 and 0.264 OD value, respectively) at the end of first, third and twelve month of storage. The probable reason for slow rate of deterioration process in boron treatment seeds might be due to primary cell wall structure, membrane functional integrity and activity of IAA oxidase.

Electrical conductivity (0.318 dSm^{-1}, 0.273 dSm^{-1} and 0.410 dSm^{-1}) of seeds leachate was significantly lowest in boron at 4 ppm which was at par with NAA at 50 ppm (0.324 dSm^{-1}, 0.286 dSm^{-1} and 0.420 dSm^{-1}), whereas, highest recorded in absolute control (0.339 dSm^{-1}, 0.335 dSm^{-1} and 0.527 dSm^{-1}) at the end of first, third and twelve month of storage period, respectively (Table 7). The lower electrical conductivity in

Table 6 : Effect of plant growth regulators and chemical on dehydrogenase enzyme activity (OD values) of bitter gourd cv. PUSA VISESH during storage

Treatments	Storage period (month)											
	1	2	3	4	5	6	7	8	9	10	11	12
T_1 : Absolute control	0.272	0.280	0.311	0.303	0.294	0.295	0.289	0.287	0.282	0.279	0.275	0.264
T_2 : Water spray	0.291	0.298	0.330	0.319	0.313	0.320	0.318	0.311	0.305	0.292	0.288	0.284
T_3 : Naphthalene acetic acid @25 ppm	0.324	0.339	0.393	0.385	0.370	0.365	0.357	0.353	0.350	0.348	0.344	0.341
T_4 : Naphthalene acetic acid @ 50 ppm	0.330	0.340	0.400	0.397	0.390	0.385	0.379	0.361	0.358	0.354	0.351	0.348
T_5 : Triacontanol @ 0.5 ppm	0.282	0.300	0.350	0.338	0.330	0.330	0.324	0.320	0.316	0.309	0.305	0.300
T_6 : Triacontanol @ 1.0 ppm	0.333	0.348	0.390	0.375	0.374	0.371	0.369	0.366	0.361	0.354	0.351	0.333
T_7 : Boron @ 3.0 ppm	0.326	0.345	0.409	0.399	0.396	0.382	0.378	0.373	0.369	0.365	0.360	0.353
T_8 : Boron @4.0 ppm	0.350	0.355	0.431	0.424	0.414	0.409	0.404	0.390	0.386	0.372	0.368	0.359
S.E.±	0.023	0.023	0.026	0.025	0.023	0.021	0.020	0.0212	0.023	0.021	0.023	0.024
C.D. (P=0.05)	0.066	0.068	0.076	0.073	0.067	0.062	0.060	0.062	0.067	0.061	0.067	0.070

Table 7 : Effect of plant growth regulators and chemical on electrical conductivity (dSm^{-1}) of bitter gourd cv. PUSA VISESH during storage

Treatments	Storage period (month)											
	1	2	3	4	5	6	7	8	9	10	11	12
T_1 : Absolute control	0.339	0.338	0.335	0.336	0.337	0.346	0.349	0.353	0.413	0.429	0.449	0.527
T_2 : Water spray	0.339	0.332	0.320	0.327	0.325	0.340	0.347	0.359	0.383	0.421	0.439	0.481
T_3 : Naphthalene acetic acid @25 ppm	0.332	0.319	0.290	0.307	0.309	0.318	0.339	0.349	0.380	0.403	0.423	0.437
T_4 : Naphthalene acetic acid @ 50 ppm	0.324	0.315	0.286	0.303	0.305	0.314	0.332	0.342	0.371	0.392	0.404	0.420
T_5 : Triacontanol @ 0.5 ppm	0.337	0.324	0.295	0.312	0.314	0.323	0.344	0.354	0.385	0.408	0.428	0.442
T_6 : Triacontanol @ 1.0 ppm	0.332	0.322	0.293	0.310	0.312	0.321	0.342	0.351	0.382	0.405	0.425	0.439
T_7 : Boron @ 3.0 ppm	0.335	0.316	0.287	0.304	0.306	0.315	0.336	0.346	0.377	0.400	0.413	0.434
T_8 : Boron @4.0 ppm	0.318	0.314	0.273	0.295	0.300	0.304	0.329	0.335	0.373	0.390	0.403	0.410
S.E.±	0.001	0.003	0.001	0.005	0.007	0.001	0.001	0.001	0.001	0.001	0.002	0.001
C.D. (P=0.05)	0.002	0.010	0.002	0.016	0.020	0.001	0.001	0.001	0.001	0.001	0.007	0.001

boron treatment might due to viability for longer period by leaching of toxic metabolites, germination advancement, antipathogenic effect, repair of biochemical lesions and counteraction of free radicals and prevention of lipid peroxidation, *etc.* as reported by Mini and Unnikrishanan (2006) in ash gourd.

However, all the treatments maintained above the minimum seed certification standards of 60 per cent of seed germination up to twelve months of storage.

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