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Standardization of pre-sowing organic seed encrustation treatments on seedling parameters of onion (*Allium cepa*) under ambient storage conditions

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Abstract

The present study was conducted from March to June at Post Graduate Lab Department of Genetics and Plant Breeding, SHUATS experiment was conducted in factorial CRD with four replications. The onion variety Gavran was taken for evaluation. Thirteen treatment combinations comprise of five treatments (Neem leaf powder (3, 5, 7 g/kg of seeds); turmeric powder (5, 10, 15%), Bael leaf powder (4, 5, 6%) and pepper powder @ 20, 25 and 30 g/kg of seed) along with control and two storage container: zip lock bag and plastic container. Seedlings stored in plastic container exhibited highest germination percent (71.92%), germination rate (2.77), root length(5.82 cm), shoot length (6.74 cm), seedling length (12.57 cm), seedling fresh weight (178.41 mg) seedling dry weight (18.91 g) vigor Index-I (916.12), vigor index-II (1.37), seedling growth rate (0.143), electrical conductivity (0.853 dSm-1) and root shoot ratio (1.167). Moreover, the seed treated with neem leaf powder @ 5 g/kg of seeds show best result in term of seed quality parameter viz germination (82.75%), germination rate (3.19), root length (4.83 cm), shoot length (9.16 cm), seedling length (17.24 cm), seedling fresh weight (191.44 g), seedling dry weight (23.65 g), vigor index I (1426.86), vigor index II (1.96), seedling growth rate (0.203), electrical conductivity (0.80 dSm-1) and root shoot ratio (1.133) as compared to control at the end of 3 months of storage. The study concluded that combining plastic containers with neem leaf powder @ 5 g/kg of seeds can expand the storability of onion seeds under ambient conditions.

Keywords: Seed encrustation, Onion, Organic, Storage container

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Introduction

Onion (*Allium cepa*) having chromosome no. 2n = 16 is a member of the "Amaryllidaceae" family. It is thought to have been domesticated in the mountain region of Afghanistan, Tajikistan, Uzbekistan, Turkmenia and North Iran. It is a major bulb crop and an important commercial vegetable grown worldwide. Due to its highly valued flavor, scent and unique taste it is known as "Queen of kitchen". Onion bulb is rich source of carbohydrates (11.0 g), protein (1.2 g), fiber (0.6 g), and moisture (86.8 g) it also contains vitamins like A, C, thiamine, riboflavin and niacin it also contains minerals like phosphorus, calcium, sodium, iron and potassium. The genus *Allium* is characterized by the presence of remarkable sulphur-containing compounds, which gives them their distinctive smell and pungency. India ranks first in area and second in production globally after China. In India, it is mainly grown in Maharashtra, Karnataka, Gujrat, Andhra Pradesh, Utter Pradesh, Odisha and Madhya Pradesh (Bhasker *et al.* 2020; Gupta *et al.* 2020; Mahajan *et al.* 2021; Gupta *et al.* 2021)

Onion seeds in general have poor longevity and lose viability rapidly under sub-tropical conditions. One of the major constraints in onion cultivation is the limited availability of vigorous seeds at the time of sowing due to poor storability under fluctuating ambient temperatures

and relative humidity. The second constraint is germination failure due to improper storage of true seeds and the third is true seeds of onion are hygroscopic in nature, high moisture content of seed encourages respiration, causing raise in heat, which favor the growth of storage molds and storage insect pests. However, lowering either of these factors during storage significantly increases storage life of seeds (Roberts 1972). Seed Encrusting is an important seed quality enhancement technique that involves the gradual accumulation of layers of adhesive and inert material on the seed together with the application of insecticides, fungicides, nutrients and growth regulators that is completely covered, but the original seed shaped is retained. Encrustment on seed is generally used in the circumstances viz. when growers primarily intend to avoid double or multiple seeds during sowing and to maintain exact and consistent seed spacing (Malik *et al.* 2020).

Seed treatments with different botanicals and bioagents reported to be safest in comparison to chemical. Several bio-agents have been declared to improve seed germination and vigor index in a variety of crops, including onion by lowering pre and post-emergence mortality. Many natural products of different plant parts have been explored for their insecticidal and anti-oxidative properties at field and storage levels. The principal purpose of storing seed of economic plants is to preserve planting stocks from one season until the next. Prehistoric man learned the necessity of this practice and developed the method of storing small quantities of seed for future use. Quality seeds are the cheapest input in modern agriculture. Therefore, the availability of viable and vigorous seed at planting time is very important for achieving targets of agriculture production because they act as a catalyst for exploiting the potential of other inputs. Hence, the present study was planned to standardize pre-sowing organic seed encrustation treatments on seedling parameters of onion under ambient conditions of storage.

Materials and Methods

The present study on standardization of pre-sowing organic seed encrustation treatment on seedling parameters of onion under ambient conditions of storage was conducted in a factorial CRD with four replications at Seed Testing Laboratory (Notified under Govt. of Uttar Pradesh), Department of Genetics and Plant Breeding, Naini Agricultural Institute (NAI), Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj, UP. The different seed treatment combinations are T_0- Control, T_1- Neem leaf powder@ 3 g/kg of seeds, T_2- neem leaf extract- 5 g/kg of seed, T_3- neem leaf extract @ 7 g/kg of seed, T_4- turmeric powder 5%, T_5- turmeric powder-10%, T_6- turmeric powder 15%, T_7- bael leaf extract 2%, T_8- bael leaf extract 4%, T_9- bael leaf extract- 6%, T_{10}- pepper powder- 5 g/kg of seed, T_{11}- pepper powder- 10 g/kg of seed and T_{12}- pepper powder 20 g/kg of seed.

Seed treatment and preparation of seeds for storage

After recording the initial seed quality parameters, seeds of onion variety Gavran was dipped in a binder (corn starch) followed by a sprinkling of filler materials for uniform and effective coating it was shaken mechanically then the seed was dried for 5 hours in shade upto safe moisture content i.e 7% and then was packed in two types of container viz., zip lock bag, plastic container and then stored under ambient condition with 25 ± 30°C temperature with 95% RH (Relative Humidity) in Seed Testing Laboratory (Notified under Govt. of Uttar Pradesh), Department of Genetics and Plant Breeding, SHUATS, Prayagraj (U.P.). Seed samples were taken every 4,8 and 12 weeks during the storage period of 12 weeks to evaluate the seedling parameters of onion (*Allium cepa)* seeds. Observation on germination percent by ISTA (2014), germination rate by Maguire (1962), shoot length(cm), root length(cm), seedling length(cm), seedling growth rate by Copeland (1976), seedling fresh weight, seedling dry weight, seedling vigor index I and seedling vigor index II by Abdul-Baki and Anderson (1973).

Statistical analysis

The observed data was statistically analyzed with the factorial concept as suggested by Steel and Torrie (1960). The data were analyzed by of variance using OPSTAT statistical software.

Results

In the present study, significant mean performance for seedling parameters were recorded by seed encrusted with neem leaf powder, turmeric powder, bael leaf powder, pepper powder as filler matter and using cornstarch as a common adhesive for 4, 8 and 12 weeks of storage period, respectively in Tables 1-6. There was a significant effect in terms of seedling parameters on onion using different botanicals. Germination percent decreased with the advancement of the storage period. The highest germination percent (71.462%) was recorded in plastic containers (C2) and the lowest (71.923%) was recorded in zip lock pouches (C1) at the end of storage period. The seed treated with neem powder (5 g/kg of seed, T_2) recorded maximum germination (82.75%) as compared to the T_0 control (59.75%) and the lowest germination percent (65.75%) was recorded in T_3 i.e., neem leaf powder (7 g/kg of seed). The combination T_2C_2 recorded the maximum germination percent (84%), while T_3C_1 was recorded the lowest germination percent (71%) at the end of the storage period. The germination rate decreases with the advancement of the storage period. A higher germination rate was recorded in seed stored in plastic containers (2.773), whereas a lower germination rate was recorded in zip lock pouches (2.754). The seed treated with neem powder (5 g/kg of seed, T_2) recorded a maximum germination rate (3.19) as compared to the T_0- control (2.30) and the lowest germination rate (2.71) was recorded in T_6- Turmeric powder (15%) and The

Table 1: Mean performance of container and treatments of seed quality parameters of onion variety Gavran after four weeks of storage

Treatment	*Germination (%)*	*Germination rate*	*Root length (cm)*	*Shoot length (cm)*	*Root shoot ratio*	*Seedling length (cm)*	*Seedling fresh weight (mg)*	*Seedling dry weight (mg)*	*Seed vigor index I*	*Seed vigor index II*	*seedling growth rate*	*EC*
C_1	90.385	3.484	5.934	6.981	1.188	12.916	178.318	19.034	1173.361	1.726	0.080	0.488
C_2	91.038	3.510	6.074	7.126	1.183	13.200	179.521	19.396	1208.193	1.772	0.088	0.565
F-Test	NS	NS	S	S	S	S	S	S	S	S	S	S
C.D. at 5%	-	-	0.062	0.061	0.004	0.122	0.348	0.158	25.485	0.034	0.005	0.053
S.Ed. (+)	0.846	0.033	0.031	0.031	0.002	0.061	0.174	0.079	12.776	0.017	0.003	0.027
S.Em	0.598	0.023	0.022	0.022	0.001	0.043	0.123	0.056	9.034	0.012	0.002	0.019
T_0	82.50	3.18	3.94	5.05	1.281	8.99	164.44	14.53	741.30	1.20	0.040	0.56
T_1	91.25	3.52	6.84	7.88	1.152	14.72	183.03	20.19	1342.28	1.84	0.116	0.58
T_2	96.50	3.72	8.34	9.38	1.124	17.72	192.19	23.93	1710.35	2.31	0.161	0.52
T_3	90.00	3.47	5.10	6.15	1.205	11.25	175.56	17.87	1012.24	1.61	0.037	0.53
T_4	94.00	3.62	8.01	9.04	1.129	17.05	188.24	23.26	1602.93	2.19	0.130	0.50
T_5	88.50	3.41	6.26	7.31	1.168	13.57	181.00	19.84	1202.00	1.76	0.071	0.47
T_6	88.25	3.40	4.83	5.86	1.212	10.69	173.48	17.34	943.17	1.53	0.039	0.52
T_7	92.00	3.55	7.20	8.24	1.145	15.43	185.47	20.77	1420.16	1.91	0.117	0.53
T_8	91.75	3.54	5.42	6.47	1.194	11.89	175.69	18.40	1091.10	1.69	0.074	0.50
T_9	91.75	3.54	4.13	5.16	1.250	9.28	170.06	15.97	851.22	1.46	0.030	0.56
T_{10}	92.25	3.56	7.51	8.54	1.137	16.05	185.86	21.87	1481.19	2.02	0.136	0.54
T_{11}	88.75	3.42	5.82	6.94	1.193	12.76	179.15	19.22	1131.95	1.71	0.082	0.52
T_{12}	91.75	3.54	4.66	5.70	1.225	10.36	171.78	16.60	951.85	1.52	0.061	0.52
F-Test	S	S	S	S	S	S	S	S	S	S	S	NS
C.D. at 0.5%	4.302	0.165	0.158	0.156	0.010	0.312	0.887	0.402	64.974	0.086	0.014	-
SEd	2.157	0.083	0.079	0.078	0.005	0.157	0.445	0.202	32.574	0.043	0.007	0.068
SEm	1.525	0.059	0.056	0.055	0.004	0.11	0.314	0.143	23.033	0.030	0.005	0.048

Table 2: Interaction effect of treatments and container on seedling parameters of onion variety Gavran at four weeks of storage

Treatment	*Germination (%)*	*Germination rate*	*Root length (cm)*	*Shoot length (cm)*	*Root shoot ratio*	*Seedling length (cm)*	*Seedling Fresh weight (mg)*	*Seedling Dry weight (mg)*	*Seed vigor I*	*Seed vigor II*	*Seedling growth rate*	*EC*
T_0xC_1	82.00	3.16	3.87	5.04	1.303	8.90	163.93	14.28	729.49	1.17	0.032	0.57
T_1xC_1	91.00	3.51	6.71	7.74	1.154	14.45	182.55	20.06	1314.27	1.83	0.085	0.53
T_2xC_1	96.50	3.72	8.26	9.27	1.122	17.52	190.95	23.67	1690.69	2.28	0.140	0.45
T_3xC_1	85.00	3.28	5.06	6.11	1.208	11.17	175.01	17.42	949.38	1.48	0.039	0.46
T_4xC_1	93.00	3.59	7.89	8.92	1.131	16.81	187.88	23.08	1563.02	2.15	0.117	0.48
T_5xC_1	88.50	3.41	6.26	7.31	1.168	13.58	180.42	19.76	1202.83	1.75	0.062	0.49
T_6xC_1	88.50	3.41	4.71	5.75	1.221	10.46	173.05	17.45	925.65	1.54	0.051	0.47
T_7xC_1	91.50	3.53	7.13	8.16	1.145	15.28	184.38	20.59	1398.21	1.88	0.134	0.45
T_8xC_1	92.50	3.57	5.36	6.40	1.194	11.76	174.64	18.24	1088.29	1.68	0.073	0.48
T_9xC_1	92.50	3.57	4.05	5.10	1.260	9.14	170.40	15.77	845.35	1.46	0.018	0.48
$T_{10}xC_1$	92.00	3.55	7.42	8.45	1.139	15.87	185.15	21.67	1460.54	1.99	0.132	0.50
$T_{11}xC_1$	89.50	3.45	5.74	6.79	1.183	12.54	178.84	19.17	1122.05	1.72	0.085	0.47
$T_{12}xC_1$	92.50	3.57	4.70	5.73	1.221	10.44	170.95	16.30	967.19	1.51	0.077	0.54
T_0xC_2	83.00	3.20	4.02	5.06	1.259	9.08	164.95	14.78	753.12	1.23	0.049	0.56
T_1xC_2	91.50	3.53	6.97	8.02	1.151	14.98	183.51	20.32	1370.30	1.86	0.147	0.62
T_2xC_2	96.50	3.72	8.43	9.49	1.126	17.93	193.42	24.20	1730.02	2.34	0.181	0.59
T_3xC_2	95.00	3.66	5.14	6.18	1.202	11.32	176.11	18.32	1075.09	1.74	0.036	0.61
T_4xC_2	95.00	3.66	8.13	9.16	1.127	17.29	188.59	23.45	1642.83	2.23	0.142	0.52
T_5xC_2	88.50	3.41	6.26	7.31	1.168	13.57	181.58	19.92	1201.17	1.76	0.081	0.45
T_6xC_2	88.00	3.39	4.96	5.97	1.204	10.92	173.91	17.24	960.69	1.52	0.027	0.57
T_7xC_2	92.50	3.57	7.27	8.32	1.144	15.59	186.57	20.95	1442.11	1.94	0.099	0.62
T_8xC_2	91.00	3.51	5.48	6.54	1.194	12.02	176.75	18.57	1093.91	1.69	0.076	0.52
T_9xC_2	91.00	3.51	4.21	5.22	1.240	9.43	169.73	16.17	857.09	1.47	0.041	0.63
$T_{10}xC_2$	92.50	3.57	7.61	8.63	1.134	16.23	186.57	22.07	1501.83	2.04	0.140	0.58
$T_{11}xC_2$	88.00	3.39	5.89	7.09	1.203	12.98	179.46	19.27	1141.86	1.70	0.079	0.57
$T_{12}xC_2$	91.00	3.51	4.62	5.67	1.229	10.29	172.62	16.90	936.51	1.54	0.045	0.51
F-Test	NS	NS	NS	NS	S	NS	NS	NS	NS	NS	S	NS
C.D. at 5%	-	-	-	-	0.015	-	-	-	-	-	0.019	-
S.Ed. (+)	3.050	0.117	0.112	0.111	0.007	0.221	0.629	0.285	46.066	0.061	0.010	0.097
S.Em	2.157	0.083	0.079	0.078	0.005	0.157	0.445	0.202	32.573	0.043	0.007	0.068

Table 3: Mean performance of container and treatments of seed quality parameters of onion variety Gavran after eight weeks of storage

Treatment	*Germination (%)*	*Germination rate*	*Root length (cm)*	*Shoot length (cm)*	*Root shoot ratio*	*Seedling length (cm)*	*Seedling Fresh weight (mg)*	*Seedling Dry weight (mg)*	*Seed vigor I*	*Seed vigor II*	*seedling growth rate*	*EC*
C_1	87.269	3.362	5.809	6.828	1.187	12.637	178.017	18.893	118.419	1.654	0.142	0.629
C_2	87.654	3.376	5.939	6.975	1.184	12.915	178.968	19.213	1138.635	1.691	0.145	0.714
F-Test	NS	NS	NS	S	NS	S	S	NS	S	NS	NS	S
C.D. at 0.5%	-	-	-	0.145	-	0.235	0.471	-	29.978	-	-	0.051
S.Ed. (+)	0.858	0.033	0.086	0.073	0.019	0.118	0.236	0.194	15.029	0.023	0.003	0.026
S.Em	0.607	0.023	0.061	0.052	0.013	0.083	0.167	0.137	10.627	0.016	0.002	0.018
T_0	80.50	3.10	3.78	4.86	1.286	8.63	164.11	14.38	694.63	1.16	0.088	0.71
T_1	88.25	3.40	6.65	7.73	1.162	14.38	182.71	20.04	1268.53	1.77	0.167	0.73
T_2	92.75	3.57	8.21	9.27	1.128	17.48	191.81	23.79	1621.74	2.21	0.205	0.66
T_3	85.75	3.30	4.97	6.01	1.211	10.98	175.22	17.73	941.37	1.52	0.114	0.67
T_4	91.50	3.52	7.89	8.90	1.127	16.79	187.92	23.11	1537.09	2.11	0.193	0.65
T_5	86.50	3.33	6.14	7.17	1.169	13.31	180.69	19.68	1151.93	1.70	0.149	0.63
T_6	85.50	3.29	4.71	5.73	1.217	10.44	173.19	17.23	892.06	1.47	0.109	0.63
T_7	87.75	3.38	7.07	8.11	1.146	15.18	185.17	20.64	1331.69	1.81	0.179	0.66
T_8	88.00	3.39	5.28	6.33	1.199	11.62	175.37	18.28	1022.94	1.61	0.128	0.62
T_9	87.75	3.38	4.02	5.00	1.244	9.02	169.72	15.83	791.33	1.39	0.095	0.70
T_{10}	88.50	3.41	7.38	8.39	1.137	15.78	185.51	21.74	1397.04	1.92	0.184	0.67
T_{11}	85.00	3.27	5.66	6.66	1.177	12.33	178.84	19.08	1047.61	1.60	0.142	0.66
T_{12}	89.25	3.44	4.60	5.57	1.212	10.16	171.45	16.45	907.90	1.46	0.106	0.67
F-Test	S	S	S	S	S	S	S	S	S	S	S	NS
C.D. at 5%	4.365	0.169	0.439	0.371	0.096	0.600	1.201	0.986	76.429	0.116	0.016	-
S.Ed. (+)	2.189	0.085	0.220	0.186	0.048	0.301	0.602	0.495	38.316	0.058	0.008	0.065
S.Em	1.548	0.060	0.156	0.131	0.034	0.213	0.426	0.350	27.094	0.041	0.006	0.046

Table 4: Interaction effect of treatments and container on seedling parameters of onion variety Gavran at eight weeks of storage

Treatment	*Germination (%)*	*Germination rate*	*Root length (cm)*	*Shoot length (cm)*	*Root shoot ratio*	*Seedling length (cm)*	*Seedling Fresh weight (mg)*	*Seedling Dry weight (mg)*	*Seed vigor I*	*Seed vigor II*	*Seedling growth rate*	*EC*
T_0xC_1	80.50	3.10	3.67	4.76	1.300	8.43	163.60	14.14	678.14	1.14	0.081	0.71
T_1xC_1	89.00	3.43	6.48	7.57	1.168	14.05	182.24	19.90	1249.77	1.77	0.158	0.69
T_2xC_1	92.50	3.56	8.12	9.16	1.128	17.27	190.59	23.55	1597.42	2.18	0.203	0.57
T_3xC_1	80.50	3.10	4.90	5.98	1.220	10.88	174.65	17.29	875.75	1.39	0.112	0.59
T_4xC_1	90.50	3.49	7.76	8.77	1.130	16.53	187.57	22.91	1495.81	2.07	0.187	0.65
T_5xC_1	86.50	3.33	6.15	7.17	1.166	13.33	180.10	19.57	1154.05	1.69	0.152	0.68
T_6xC_1	86.00	3.31	4.61	5.64	1.224	10.25	172.80	17.34	881.56	1.49	0.112	0.58
T_7xC_1	89.00	3.43	7.01	8.01	1.143	15.01	184.15	20.46	1335.90	1.82	0.178	0.58
T_8xC_1	87.50	3.37	5.23	6.27	1.199	11.50	174.36	18.11	1006.82	1.58	0.125	0.61
T_9xC_1	89.50	3.45	3.97	4.96	1.250	8.92	170.09	15.63	798.23	1.40	0.091	0.62
$T_{10}xC_1$	86.50	3.33	7.31	8.32	1.138	15.63	184.89	21.54	1352.91	1.86	0.182	0.63
$T_{11}xC_1$	86.50	3.33	5.73	6.57	1.147	12.30	178.56	19.03	1064.16	1.65	0.144	0.61
$T_{12}xC_1$	90.00	3.47	4.59	5.59	1.219	10.19	170.64	16.15	918.95	1.45	0.114	0.69
T_0xC_2	80.50	3.10	3.89	4.95	1.273	8.84	164.62	14.62	711.12	1.18	0.096	0.72
T_1xC_2	87.50	3.37	6.83	7.89	1.155	14.71	183.18	20.18	1287.29	1.77	0.176	0.76
T_2xC_2	93.00	3.58	8.31	9.38	1.129	17.70	193.03	24.04	1646.06	2.24	0.207	0.75
T_3xC_2	91.00	3.50	5.03	6.04	1.201	11.07	175.79	18.18	1006.98	1.65	0.116	0.75
T_4xC_2	92.50	3.56	8.03	9.03	1.125	17.06	188.26	23.32	1578.38	2.16	0.199	0.65
T_5xC_2	86.50	3.33	6.12	7.17	1.172	13.29	181.27	19.78	1149.81	1.71	0.145	0.59
T_6xC_2	85.00	3.27	4.81	5.82	1.210	10.62	173.58	17.13	902.55	1.46	0.107	0.68
T_7xC_2	86.50	3.33	7.14	8.21	1.150	15.35	186.20	20.82	1327.49	1.80	0.179	0.75
T_8xC_2	88.50	3.41	5.34	6.40	1.199	11.74	176.39	18.46	1039.06	1.63	0.132	0.63
T_9xC_2	86.00	3.31	4.08	5.05	1.238	9.13	169.36	16.03	784.44	1.38	0.099	0.77
$T_{10}xC_2$	90.50	3.49	7.46	8.47	1.136	15.92	186.13	21.94	1441.18	1.98	0.186	0.71
$T_{11}xC_2$	83.50	3.22	5.60	6.75	1.207	12.35	179.13	19.13	1031.05	1.56	0.140	0.71
$T_{12}xC_2$	88.50	3.41	4.60	5.54	1.205	10.14	172.26	16.75	896.86	1.47	0.097	0.66
F-Test	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.D. at 5%	-	-	-	-	-	-	-	-	-	-	-	-
S.Ed. (+)	3.095	0.120	0.311	0.263	0.068	0.425	0.851	0.699	54.187	0.082	0.012	0.092
S.Em	2.189	0.085	0.220	0.186	0.048	0.301	0.602	0.495	38.316	0.058	0.008	0.065

Table 5: Mean performance of container and treatments of seed quality parameters of onion variety Gavran after twelve weeks of storage

Treatment	*Germination (%)*	*Germination rate*	*Root length (cm)*	*Shoot length (cm)*	*Root shoot ratio*	*Seedling length (cm)*	*Seedling Fresh weight (mg)*	*Seedling Dry weight (mg)*	*Seed vigor I*	*Seed vigor II*	*seedling growth rate*	*EC*
C_1	71.462	2.754	5.683	6.675	1.186	12.358	177.716	18.751	892.902	1.350	0.139	0.771
C_2	71.923	2.773	5.825	6.745	1.167	12.570	178.415	18.914	916.128	1.372	0.143	0.853
F-Test	NS	NS	S	NS	NS	S	S	NS	NS	NS	NS	S
C.D. at 5%	-	-	0.103	-	-	0.198	0.521	-	-	-	-	0.056
S.Ed. (+)	0.994	0.038	0.052	0.076	0.016	0.099	0.261	0.146	12.270	0.022	0.003	0.028
S.Em	0.703	0.027	0.037	0.054	0.011	0.070	0.185	0.103	8.676	0.015	0.002	0.020
T_0	59.75	2.30	3.61	4.67	1.293	8.28	163.78	14.23	496.26	0.85	0.085	0.86
T_1	72.25	2.79	6.47	7.58	1.172	14.05	182.39	19.89	1015.10	1.44	0.165	0.88
$_T$2	82.75	3.19	8.08	9.16	1.133	17.24	191.44	23.65	1426.86	1.96	0.203	0.80
T_3	65.75	2.54	4.83	5.88	1.217	10.71	174.88	17.60	702.93	1.15	0.111	0.80
T_4	77.75	3.00	7.78	8.76	1.126	16.54	187.60	22.96	1285.71	1.79	0.191	0.80
T_5	70.50	2.72	6.01	7.03	1.170	13.04	180.37	19.51	920.57	1.38	0.148	0.80
T_6	70.25	2.71	4.58	5.60	1.222	10.18	172.90	17.12	714.87	1.20	0.106	0.74
T_7	71.50	2.76	6.95	7.98	1.148	14.92	184.87	20.51	1066.60	1.47	0.176	0.79
T_8	67.75	2.61	5.15	6.20	1.204	11.35	175.05	18.16	769.01	1.23	0.125	0.74
T_9	76.25	2.94	3.92	4.85	1.238	8.76	169.38	15.69	667.98	1.20	0.092	0.84
T_{10}	76.25	2.94	7.25	8.25	1.137	15.50	185.16	21.61	1180.83	1.65	0.180	0.80
T_{11}	67.75	2.61	5.61	5.95	1.064	11.55	178.54	18.94	782.02	1.23	0.138	0.80
T_{12}	73.50	2.83	4.57	5.35	1.174	9.92	171.11	16.30	729.96	1.15	0.113	0.82
F-Test	S	S	S	S	S	S	S	S	S	S	S	NS
C.D. at 5%	5.053	0.195	0.264	0.386	0.080	0.505	1.328	0.740	62.399	0.110	0.017	-
S.Ed. (+)	2.533	0.098	0.132	0.193	0.040	0.253	0.666	0.371	31.282	0.055	0.009	0.071
S.Em	1.791	0.069	0.093	0.137	0.029	0.179	0.471	0.262	22.120	0.039	0.006	0.050

combination T_2C_2 recorded the maximum germination rate (3.24) while T_6C_2 was recorded lowest germination rate (2.72) at the end of the storage period of 12 weeks.

Root length decreased with the advancement of the storage period. Higher root length was recorded in seed stored in plastic containers (6.074, 5.939, 5.825 cm), whereas the lower root length was recorded in zip lock pouches (5.934, 5.809, 5.683 cm). The seed treated with neem powder (5 g/kg of seed, T_2) recorded maximum root length (8.34, 8.21, 8.08 cm) as compared to the (T_0) control (3.94, 3.78, 3.61 cm) and lowest root length (4.13, 4.02, 3.92 cm) was recorded in (T_9) bael leaf powder (6%). The combination T_2C_2 recorded the maximum root length (8.19 cm) while T_9C_1 was recorded lowest root length (3.89 cm) at the end of the storage period. Moreover, shoot length decreased with the advancement of the storage period, higher shoot length was recorded in seed stored in plastic containers (7.126, 6.975, 6.745 cm), whereas the lower shoot length was recorded in zip lock pouches (6.981, 6.828, 6.675 cm). The seed treated with neem powder (5 g/kg of seed) (T_2) recorded maximum shoot length (9.38, 9.27, 9.16 cm) as compared to the T_0 control (5.05, 4.86, 4.67 cm) and lowest root length 5.16, 5.00, 4.85 cm was recorded in T_9-bael leaf powder (6%). The combination T_2C_2 recorded the maximum shoot length (9.05 cm) while T_9C_1 was recorded the lowest shoot length (6.14 cm) at the end of the storage period. Root shoot ratio decreased with the advancement of storage period. Higher root shoot ratio was recorded in seed stored in plastic containers (1.183, 1.184, 1.167 cm), whereas a lower root shoot ratio was recorded in zip lock pouches (1.188, 1.187, 1.186 cm). The seed treated with neem powder (5 g/kg of seed, T_2) recorded maximum root shoot ratio (1.124, 1.128, 1.133) as compared to the control (1.281, 1.286, 1.293) and root shoot ratio (1.250, 1.244, 1.238) was recorded in (T_9) bael leaf powder (6%). The combination T_2C_2 recorded the maximum root shoot ratio (1.132) while T_9C_1 was recorded the lowest root shoot ratio (1.239) at the end of the storage period.

Seedling length decreased with the advancement of the storage period higher seedling length was recorded in seed stored in plastic container (13.200, 12.915, 12.570 cm) whereas the lower seedling length was recorded in zip lock pouches (12.916, 12.637, 12.358 cm). The seed treated with neem powder (5 g/kg of seed, T_2) recorded maximum seedling length (17.72, 17.48, 17.24 cm) as compared to the control (8.99, 8.63, 8.28 cm) and lowest seedling length (9.28, 9.02, 8.72 cm) was recorded in (T_9) bael leaf powder (6%). The combination T_2C_2 recorded the maximum seedling length

Table 6: Interaction effect of treatments and container on seedling parameters of onion variety Gavran at Twelve weeks of storage

Treatment	*Germination (%)*	*Germination rate*	*Root length (cm)*	*Shoot length (cm)*	*Root shoot ratio*	*Seedling length (cm)*	*Seedling Fresh weight (mg)*	*Seedling Dry weight (mg)*	*Seed vigor I*	*Seed vigor II*	*Seedling growth rate*	*EC*
T_0xC_1	54.00	2.08	3.47	4.49	1.298	7.96	163.27	14.00	429.48	0.76	0.077	0.85
T_1xC_1	71.50	2.76	6.25	7.40	1.184	13.65	181.93	19.74	976.26	1.41	0.155	0.85
T_2xC_1	81.50	3.14	7.98	9.05	1.134	17.02	190.23	23.43	1387.44	1.91	0.200	0.69
T_3xC_1	71.00	2.74	4.74	5.85	1.234	10.59	174.29	17.16	751.72	1.22	0.109	0.72
T_4xC_1	76.50	2.95	7.63	8.62	1.130	16.25	187.26	22.74	1242.46	1.74	0.184	0.82
T_5xC_1	68.50	2.64	6.04	7.03	1.164	13.08	179.78	19.38	897.53	1.33	0.153	0.87
T_6xC_1	70.00	2.70	4.51	5.53	1.226	10.04	172.55	17.23	702.66	1.21	0.108	0.69
T_7xC_1	70.50	2.72	6.89	7.86	1.141	14.74	183.92	20.33	1039.07	1.43	0.175	0.71
T_8xC_1	66.50	2.56	5.10	6.14	1.204	11.24	174.08	17.98	747.58	1.19	0.122	0.74
T_9xC_1	80.50	3.10	3.89	4.82	1.239	8.70	169.78	15.49	700.39	1.25	0.089	0.76
$T_{10}xC_1$	76.00	2.93	7.20	8.19	1.138	15.39	184.63	21.41	1168.27	1.63	0.178	0.76
$T_{11}xC_1$	68.50	2.64	5.72	6.35	1.111	12.07	178.28	18.89	826.75	1.29	0.141	0.75
$T_{12}xC_1$	74.00	2.85	4.48	5.45	1.218	9.94	170.33	16.00	738.15	1.18	0.117	0.84
T_0xC_2	65.50	2.53	3.76	4.84	1.287	8.60	164.29	14.46	563.05	0.95	0.093	0.88
T_1xC_2	73.00	2.81	6.69	7.76	1.160	14.44	182.85	20.04	1053.94	1.46	0.174	0.90
T_2xC_2	84.00	3.24	8.19	9.27	1.132	17.47	192.64	23.88	1466.29	2.00	0.205	0.91
T_3xC_2	60.50	2.33	4.92	5.90	1.199	10.82	175.47	18.04	654.14	1.09	0.114	0.89
T_4xC_2	79.00	3.05	7.93	8.90	1.122	16.83	187.93	23.19	1328.97	1.83	0.197	0.78
T_5xC_2	72.50	2.80	5.98	7.03	1.176	13.01	180.96	19.64	943.61	1.42	0.143	0.73
T_6xC_2	70.50	2.72	4.66	5.67	1.217	10.32	173.25	17.02	727.08	1.20	0.105	0.79
T_7xC_2	72.50	2.80	7.01	8.10	1.156	15.11	185.83	20.69	1094.13	1.50	0.176	0.88
T_8xC_2	69.00	2.66	5.20	6.26	1.204	11.46	176.03	18.35	790.43	1.27	0.128	0.74
T_9xC_2	72.00	2.78	3.95	4.88	1.236	8.83	168.99	15.89	635.58	1.14	0.095	0.91
$T_{10}xC_2$	76.50	2.95	7.31	8.31	1.137	15.61	185.69	21.81	1193.38	1.67	0.182	0.84
$T_{11}xC_2$	67.00	2.58	5.50	5.54	1.016	11.04	178.80	18.99	737.30	1.17	0.135	0.85
$T_{12}xC_2$	73.00	2.81	4.65	5.24	1.130	9.89	171.90	16.60	721.78	1.12	0.110	0.81
F-Test	S	S	NS	NS	NS	NS	S	NS	S	NS	NS	NS
C.D. at 5%	7.146	0.276	-	-	-	-	1.878	-	88.245	-	-	-
S.Ed. (+)	3.582	0.138	0.187	0.274	0.057	0.358	0.942	0.525	44.240	0.078	0.012	0.100
S.Em	2.533	0.098	0.132	0.193	0.040	0.253	0.666	0.371	31.282	0.055	0.009	0.071

(17.47cm) while T_9C_1 was recorded lowest seedling length (8.70) at the end of the storage period. The fresh weight of seedlings decreases with the advancement of storage period higher seedling fresh weight was recorded in seed stored in plastic containers (179.521, 178.968, 178.415 mg), whereas the lower seedling fresh weight was recorded in zip lock pouches (178.318, 178.017, 177.716 mg) The seed treated with neem powder (5 g/kg of seed, T_2) recorded maximum seedling fresh weight (192.19, 191.81, 191.44 mg) as compared to the (T_0) control (164.44, 164.11, 163.39 mg) and lowest seedling fresh weight (170.06, 169.72, 169.38 mg) was recorded in (T_9) bael leaf powder. The combination T_2C_2 recorded the maximum seedling fresh weight (192.64 mg) while T_9C_2 was recorded the lowest seedling fresh weight (168.99 mg) at the end of the storage period of 12 weeks. Moreover, seedling dry weight decreased with the advancement of storage period. Higher seedling dry weight was recorded in seed stored in plastic containers (19.396,19.213,18.914 mg), whereas the lower seedling dry weight was recorded in zip lock pouches (19.034, 18.893, 18.751 mg). The seed treated with neem powder (5g/kg of seed, T_2) recorded maximum seedling dry weight (23.93, 23.79, 23.65 mg) as compared to the control (14.53, 14.38, 14.23 mg) and lowest seedling dry weight (15.97, 15.83. 15.69 mg) was recorded in (T_9) bael leaf powder. The combination T_2C_2 recorded the maximum seedling dry weight (23.88 mg) while T_9C_2 recorded the lowest seedling fresh weight (15.89 mg) at 12 weeks of storage.

Vigor index I decreased with advancement of storage higher vigor index I was recorded in seed stored in a plastic container (1208.193, 1138.635, 916.128) whereas the lower vigor index I was recorded in zip lock pouches (1173.361, 118.419, 892.902) The seed treated with neem powder (5 g/kg of seed, T_2) recorded maximum seedling growth rate (1710.35, 1621.74, 1426.86) as compared to the control

(741.30, 694.63, 496.26) and lowest seedling growth rate (851.22, 791.33, 667.98) was recorded in (T_9) bael leaf powder. The combination T_2C_2 recorded the maximum vigor index I (1466.29), while T_9C_1 recorded the lowest vigor index I (700.39) at the end of the storage period. Further, the vigor index II decreased with the advancement of storage. Higher vigor index II was recorded in seed stored in plastic containers (1.772, 1.691, 1.372), whereas the lower vigor index II was recorded in zip lock pouches (1.726, 1.654, 1.350). The seed treated with neem powder (5 g/kg of seed) recorded maximum vigor index II (2.13, 2.21, 1.96) as compared to the control (1.20, 1.16, 0.85) and lowest vigor Index II (1.46, 1.39, 1.20) was recorded in bael leaf powder (6%). The combination T_2C_2 recorded the maximum vigor index II (2.00) while T_9C_1 was recorded the lowest vigor index II (1.25) at the end of 12 week storage period. The electrical conductivity decreased with the advancement of storage. Higher EC was recorded in seed stored in plastic containers (0.565, 0.714, 0.853), whereas the EC was recorded in zip lock pouches (0.488, 0.629, 0.771). The seed treated with neem powder (5 g/kg of seed) recorded lower EC (0.52, 0.66, 0.80) as compared to the control (0.56, 0.71, 0.86) and EC (0.56, 0.70, 0.84) was recorded in (T_9). The combination T_2C_2 recorded the maximum EC (0.91) while T_9C_1 recorded lowest EC (0.76) at the end of the storage period.

Discussion

It was observed that onion seeds when encrusted with neem leaf powder @ 5 g/kg of seeds, there were higher germination percentage, germination rate, root length, shoot length, root shoot ratio, seedling length, seedling growth rate, vigor index I, vigor index II and electrical conductivity was recorded high after twelve weeks of storage. The better performance of neem leaf powder might be because it contains quercetin (flavonoid), nimbosterol, and a number of liminoids. These properties are having antibacterial and antifungal properties that may lengthen seed longevity in storage. Neem products may also repeal insects, stop their feeding, inhibit reproduction, and cause other interruption (Schumuttere 1990). However, Khatun *et al.* (2011) reported that the lentil seeds were treated with neem leaf powder and stored till next planting time it has improved the seed quality such as moisture content, germination capacity, root length, shoot length of the seedling and vigor index. Srimathi *et al.* (2013) reported that p. pinnate seed when pelleted with neem leaf powder, it maximized the seedling germination at the end of 9 month of storage Followed by turmeric powder as it contains demethoxycurcumin,5-methoxycurcumin are found to be natural antioxidant, anti-inflammatory and the lowest was found in bael leaf powder. Overall, plastic container performed best compared to zip lock pouches, and these results support the findings of Khan *et al.* (2018). It is concluded from this study that botanicals leaf powders seed encrustation can be used to improve the longevity of seeds through protecting the seeds from fungal and insect attack but also improve the seeds quality, the onion variety Gavran when encrusted with neem leaf powder @ 5 g/kg of seed performed better in terms of germination percent, germination rate, root length, shoot length, root shoot ratio, seedling length, seedling fresh weight, seedling dry weight, seedling growth rate, vigor index I, vigor index II, electrical conductivity as compared to other organic encrusted treatment. Seeds packed in plastic containers recorded higher germination percent, germination rate, root length, shoot length, root shoot ratio, seedling length, seedling fresh weight, seedling dry weight, seedling growth rate, vigor index I, vigor index II, electrical conductivity as compared to zip lock pouches at the end of twelve weeks. The study concluded that the combination of plastic container with neem leaf powder @ 5 g/kg of seed is the best combination that could be used to expand the storability of onion seeds under ambient conditions of storage.

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सारांश

वर्तमान अध्ययन फैक्टोरियल सी.आर.डी. में 4 पुनारावृत्ति के माध्यम से प्याज की किस्म 'गबरान' का मूल्यांकन 13 उपचार संयोंजो जिनमें 5 उपचारों (नीम पत्ती पाउडर, 3, 5, 7 ग्राम/किग्रा. बीजों); हल्दी पाउडर (5 प्रतिशत, 10 प्रतिशत, 15 प्रतिशत), बेल पत्ती पाउडर (4 प्रतिशत, 5 प्रतिशत, 6 प्रतिशत) तथा मिर्च पाउडर (20, 25 व 30 ग्राम प्रति किग्रा. बीज) नियंत्रक के साथ समाहित कर एवं दो भण्डारण पात्रों जीप लाक बैग तथा प्लास्टिक पात्र में रखकर किया गया। प्लास्टिक पात्र में रखे गयेबीजों का सबसे अधिक जमाव (71.92 प्रतिशत), जमावदर (2.77), जड़ की लम्बाई (5.82 सेमी.) प्ररोह लम्बाई (6.74 सेमी.), नवोद्भिद पौध की लम्बाई (12.57 सेमी.) नवोद्भिद पौध का ताजा भार (178.41 मिग्रा.), नवोद्भिद पौध की शुष्क भार (18.91 ग्राम), ओज गुणांक-प् (916.12, ओज गुणांक- प्प् (1.37), नवोद्भिद पौध वृद्धि दर (0.143), विद्युत चालकता (0.853 डी.एस.एम.-1) तथा जड़-प्ररोह अनुपात (1.167) पाया गया। इसके अतिरिक्त नीम पत्ती पाउडर की दर 5 ग्राम प्रति किग्रा. की दर से शोधित बीजों से सबसे उत्तम परिणाम गुणवत्ता घटकों जैसे-जमाव (82.75 प्रतिशत) हमाव दर (3.19), जड़ की लम्बाई (4.83 सेमी.), प्ररोह की लम्बाई (9.16 सेमी.), नवोद्भिद पौध की लम्बाई (17.24 सेमी.), नवोद्भिद पौध का ताजा भार (191.44 ग्राम), नवोद्भिद पौध का शुष्क भार (23.65 ग्राम), ओज गुणांक-प् (1426.86), ओज गुणांक- प्प् (1.96), नवोद्भिद पौध का विकास दर (0.203), विद्युत चालकता (0.80 डी.एस.एम.-1) तथा जड़ प्ररोह अनुपात (1.133) नियंत्रक की तुलना में 3 महीने के भण्डारण उपरान्त पाया गया। अध्ययन से स्पष्ट हुआ कि प्लास्टिक पात्र में नीम पत्ती पाउडर की 5 ग्राम/किग्रा. बीजों के साथ रखने से सामान्य तापक्रम की दशा में भण्डारण के समय में वृद्धि की जा सकती है।