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Effect of seed pelleting on longevity of onion (*Allium cepa* L.) seeds during storage

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Abstract
The study entitled "Effect of seed pelleting on longevity of onion (*Allium cepa* L.) seeds during storage" was carried out from summer 2020 and onwards at the Seed Testing Laboratory, Department of Seed Science and Technology, College of Agriculture, Junagadh Agricultural University, Junagadh. The experimental material comprised of different seed pelleting treatments [P_1: Raw seed (absolute control), P_2: Standard pellet (Control) (Carbandazim), P_3: Thiamethoxam, P_4: Seed priming + standard pellet, P_5: Nano nutrition (Zn, Fe), P_6: Biostimulant mixture, P_7: Biological (*Bacillus* spp.), P_8: Micronutrients mixture 1 (Regular phosphorus, manganese, sulphur, copper, zinc and molybdenum) and P_9: Micronutrients mixture 2 (Nano phosphorus, potassium, manganese, sulphur, copper, zinc and molybdenum)] were evaluated. After seed pelleting treatments, the seeds were stored in cold storage conditions and the observations on germination percentage and seed vigour parameters were recorded at two months interval up to fourteen month of storage (up to germination went down below 70%). The results were analyze using Completely Randomized Design. After fourteen months of storage, significantly the maximum germination (80.33%), seedling length (10.59 cm), seedling dry weight (14.64 mg), seedling vigour index I (850.41) and seedling vigour index II (1176.16) was recorded in seeds pelleted with micronutrient mixture 2 (P_9: Nano phosphorus, potassium, manganese, sulphur, copper, zinc and molybdenum), while it was recorded lower (15.00%, 3.42 cm, 2.93 mg, 50.80 and 58.95, respectively) in seed priming and seed pelleting (P_4).

Keywords: Onion, seed longevity, seed pelleting, storage

Introduction

Onion (*Allium cepa* L.), indeed belong to the genus *Allium* within the family *Alliaceae*. Onion is characterized as a monophyletic monocot within the clad *Liliales*, which means they share a common ancestor and form a distinct evolutionary group within the larger plant classification (Sharma and Sharma, 2006) [19]. The growth pattern of onion is cross-pollinated monocot grown in the cool season. Onion is typically grown as biennials or perennials, producing bulbs in the first year and flowering in the second year. However, they are often harvested and used before they reach the flowering stage. They are known for their distinctive taste and aroma, and they are used in a wide range of dishes to enhance flavour. Additionally, onion has been utilized for their potential medicinal properties and has been traditionally used for various health benefits.

Seed pelleting is a seed treatment method commonly used in agriculture. It involves encasing individual seeds or a small group of seeds with a protective and often nutrient-rich filler material, creating a larger, spherical unit. This pelleted seed unit is designed to have a consistent size, shape, and weight, which can make planting more precise and efficient (Vanangamudi *et al*., 2010) [23]. Seed pelleting is a technique used in agriculture to improve the handling, planting, and establishment of seeds with respect to physiological, physical and health attributes. It involves the application of various materials to the surface of seeds, forming a protective layer or coating in such a way that they affect the seed or soil at the seed soil interface.

Onion seeds possessed high commercial value, therefore, the availability of satisfactory vigoor for onion seeds is desirable. Seed vigour influences plant growth and performance, the passage highlights the necessity for a more thorough exploration and identification of the specific interactions between seed vigor and subsequent stages of plant development. Compared to many other crops, onion has a fairly intricate life cycle involving several distinct development phases. Onion seeds are indeed known for having relatively short viability compared to seeds of other common vegetable crops.

Onion seeds tend to lose their viability relatively quickly after being harvested unless proper storage conditions are maintained. The percentage and rate of germination of onion seeds vary noticeably among seed lots, leads to difficulties in establishing optimum plant populations in the field. Factors like, moisture content, temperature and oxygen partial pressure have the greatest influence on the longevity of seeds during storage (Amjad and Anjum 2002) [3]. There are several simple techniques available to conserve the viability of seeds over long periods of time through *ex situ* conservation. Maintaining seed viability is crucial for preserving the genetic integrity of stored samples and ensuring the availability of viable seeds for future planting in the next season. Alhamdan *et al*. (2011) [2] reported that, the speed of decline in seed quality is mainly dependent on storage temperature, relative humidity, seed moisture content, length of storage, type of seed and seed quality. The demand for high-quality vegetable seeds has been on the rise due to various factors, including advancements in technology and changes in agricultural practices (Rodo and Filho, 2003) [17].

In view of the above problems, the present study was carried out to find out to ascertain the influence of pelleting on longevity of onion seeds.

Materials and Methods

The experiment was conducted from summer 2020 and onwards at the laboratory of Department of Seed Science and Technology, College of Agriculture, Junagadh Agricultural University, Junagadh. The experimental material comprised of different seed pelleting treatments [P_1: Raw seed (absolute control), P_2: Standard pellet (Control) (Carbandazim), P_3: Thiamethoxam, P_4: Seed priming + standard pellet, P_5: Nano nutrition (Zn, Fe), P_6: Biostimulant mixture, P_7: Biological (*Bacillus* spp.), P_8: Micronutrients mixture 1 (Regular phosphorus, manganese, sulphur, copper, zinc and molybdenum) and P_9: Micronutrients mixture 2 (Nano phosphorus, potassium, manganese, sulphur, copper, zinc and molybdenum)] were evaluated. The different seed pelleting treatments were given to seeds of onion by INCOTEC India Pvt. Ltd., Ahmadabad. Chemicals/materials/micronutrients used for pelleting the seeds from treatments P_2 to P_8 were used in powder form, while in P_9, it was in liquid form. After seed pelleting treatments, the seeds were stored in cold storage conditions and the observations on germination percentage, seedling length (cm), seedling dry weight (mg), seedling vigour index I and seedling vigour index II were recorded at two months interval up to fourteen month of storage (up to germination went down below 70%). The experimental data of experiment was analyzed according to Completely Randomized Design as suggested by Panse and Sukhatme (1985) [13].

Results and Discussion

Different seed pelleting treatments exhibited non-significant difference for germination after two, four, six and eight months of storage, while it exerted significant difference after ten, twelve and fourteen months of storage under cold storage condition. After two months of storage, the maximum germination (98.67%) was recorded in seeds pelleted with micronutrient mixture 2 (P_9: Nano phosphorus, potassium, manganese, sulphur, copper, zinc and molybdenum) and the lowest germination (95.67%) was recorded in control (P_1). Germination percentage was decreased gradually with increased in storage period. After fourteen months of storage, significantly the maximum germination (80.33%) was recorded in seeds pelleted with micronutrient mixture 2 (P_9: Nano phosphorus, potassium, manganese, sulphur, copper, zinc and molybdenum) and it was at par with seeds pelleted with micronutrient mixture 1 (P_8: Regular phosphorus, manganese, sulphur, copper, zinc and molybdenum) and Biostimulant mixture (P_6: Biologically derived nutritional product contains humic acid plus calcium, magnesium, sulfur, cobalt, copper, iron, manganese, molybdenum and zinc) with 77.33 percent and 76.33 percent germination, respectively. Significantly the lowest germination (15.00%) was recorded in seed priming with seed pelleting (P_4) after 14 months of storage (Table 1). The results are in line up with the findings of Valsikova *et al.* (2012) [22], Swati (2017) [20], Yogeesha *et al.* (2017) [25] and Panwar and Thakur (2019) [14] in onion. The similar findings were reported by Satishkumar *et al.* (2014) [18] in Brinjal and Klarod *et al.* (2021) [9] in Tomato.

Different pelleting treatments exhibited significant difference for seedling length (cm), seedling dry weight (mg), seedling vigour index I and seedling vigour index II for all the storage periods under cold storage condition. After two months of storage, significantly the maximum seedling length (16.47 cm), seedling dry weight (30.10 mg), seedling vigour index I (1625.44) and seedling vigour index II (2969.97) were recorded in seeds pelleted with micronutrient mixture 2 (P_9: Nano phosphorus, potassium, manganese, sulphur, copper, zinc and molybdenum) and it was at par with seeds pelleted with micronutrient mixture 1 (P_8: Regular phosphorus, manganese, sulphur, copper, zinc and molybdenum) with 16.34 cm seedling length, 29.67 mg seedling dry weight, 1601.28 seedling vigour index I and 2907.74 seedling vigour index II, respectively, while the lowest seedling length (13.61 cm), seedling dry weight (25.50 mg), seedling vigour index I (1301.58) and seedling vigour index II (2439.41) were recorded in control (P_1). Seed quality parameters were decreased gradually with increased in storage period. After fourteen months of storage, significantly the maximum seedling length (10.59 cm), seedling dry weight (14.64 mg), seedling vigour index I (850.41) and seedling vigour index II (1176.16) were recorded in seeds pelleted with micronutrient mixture 2 (P_9: Nano phosphorus, potassium, manganese, sulphur, copper, zinc and molybdenum) and it was followed by seeds pelleted with micronutrient mixture 1 (P_8: Regular phosphorus, manganese, sulphur, copper, zinc and molybdenum) with 9.12 cm seedling length, 12.46 mg seedling dry weight, 736.30 seedling vigour index I and 963.56 seedling vigour index II, respectively. Significantly the lowest seedling length (3.42 cm), seedling dry weight (2.93 mg), seedling vigour index I (50.80) and seedling vigour index II (58.95) were recorded in seed priming with seed pelleting (P_4) (Table 2 to 4). The results are in line up with the findings of Swati (2017) [20], Yogeesha *et al.* (2017) [25] and Panwar and Thakur (2019) [14] in onion. The similar findings were reported by Satishkumar *et al.* (2014) [18] in Brinjal and Klarod *et al.* (2021) [9] in Tomato.

Seed pelleting is the process of increasing seed size with the application of external natural or chemical materials in such a way that it would be impossible to discriminate in original shape of the seed (Pedrini *et al.*, 2017) [15]. The vanishing of the priming effects during storage and the reduction in the longevity of primed seeds are the disadvantages associated with the application of priming techniques. Tu *et al.* (2022)

[21] in their study reported significant reduction in the longevity of primed seeds compared to non-primed seeds. In the present study, in P_4 treatment (seed priming + standard pellet), the germination and vigour reduced drastically after eight months after storage. The results are in line up with the findings of Argerich *et al.* (1989) [4], Chiu *et al.* (2002) [7] and Wang *et al.* (2018) [24]. Argerich *et al.* (1989) [4] found that, after 6 months of storage at 30 °C, primed tomato seeds showed delay in germination as well as low germination percentage compared to the non-primed seeds. Chiu *et al.* (2002) [7] reported that, primed sweet corn seeds recorded poor germination and seedling vigour after storage for 3 months at 25 °C than non-primed seeds. Wang *et al.* (2018) [24] reported that, primed seeds of rice stored under high relative humidity condition beyond 15 days are poor in germination and vigour, and such detrimental effects were related with reduced starch metabolism, consumption of starch reserves in rice endosperm, increased lipid peroxidation levels and decreased antioxidant enzyme activities.

Mixture of micronutrients or a biostimulant could have positive effects on plant growth. These effects might be due to the presence of active compounds in these substances that interact synergistically with amino acids, specifically tryptophan, to produce indole-3-acetic acid (IAA) during the germination of seeds, resulting in development in seedling growth (Krishnasamy and Basaria Begam, 2003). Improved seed quality parameters, including germination rates, could be attributed to the presence of physiologically active substances in the micronutrient mixture. These substances might have activated the embryo and other related structures within the seed, resulting in the development of a stronger and more efficient root system, as well as a higher vigour index.

Micronutrients, also known as trace elements, are essential elements that plants require in smaller quantities compared to macronutrients like nitrogen, phosphorus, and potassium. Despite their relatively low concentrations in plants, micronutrients play crucial roles in various biochemical and physiological processes, supporting overall plant health (Kumar *et al.,* 2020). Role of micronutrient availability in promoting successful germination and healthy seedling development is very crucial. Micronutrients are essential for a range of functions includes the stabilization of membranes, the elimination of free radicals, and secondary plant metabolism, that contribute to the overall health and vitality of plants during early stages (Afzal *et al*., 2015)[1]. Plant scientists have developed various seed augmentation strategies aimed at enhancing the germination process, achieving synchronized and uniform emergence, and improving overall seedling stand in field crops. These strategies are crucial for optimizing crop yields and ensuring successful crop establishment. An appealing and simple option is micronutrient seed treatments, which include seed priming and seed coating/pelleting. The potential reasons behind the observed improvement and maintenance of high germination rates through the use of a micronutrient mixture are attributed to various factors related to plant secondary metabolites, membrane stabilization, and free radical detoxification facilitated by the mineral elements present in the mixture (Mondal and Bose, 2019) [12].

The decrease in germination and seedling vigour parameters with increasing storage period could be attributed to the damage to membranal enzyme, proteins and nucleic acids resulting in the complete disorganization of membranes and cell organelles (Roberts, 1972). The reduction in germination percentage observed in all the seed pelleting treatments with increasing storage period could be attributed to several factors related to the aging of seeds and the degradation of their components as reported by Chandra Senan (1996) [6] in Chilli, Joeraj (2000) [8] in sunflower and Basavegowda and Nanjareddy (2008) [5] in groundnut.

Table 1: Effect of seed pelleting on germination (%) in onion seeds during storage

Factor	2 months after storage	4 months after storage	6 months after storage	8 months after storage	10 months after storage	12 months after storage	14 months after storage
P_1	95.67	92.67	88.33	86.67	84.00	72.33	68.00
P_2	96.67	95.00	93.33	91.00	86.67	78.00	73.67
P_3	96.00	94.33	92.00	90.67	87.00	77.33	75.00
P_4	96.67	94.67	94.33	93.00	52.67	44.00	15.00
P_5	96.33	94.00	93.00	92.67	89.67	79.67	72.33
P_6	96.33	95.33	93.67	91.00	89.00	79.00	76.33
P_7	97.00	94.67	93.00	91.33	89.00	82.00	75.00
P_8	98.00	95.00	93.00	92.00	89.33	83.33	77.33
P_9	98.67	96.00	95.33	93.67	90.33	85.00	80.33
S.Em+	0.75	1.03	1.46	1.29	0.85	1.31	1.61
C.D. at 5%	NS	NS	NS	NS	2.54	3.89	4.77
CV%	1.33	1.89	2.73	2.44	1.76	3.00	4.08

Table 2: Effect of seed pelleting on seedling length (cm) in onion seeds during storage

Factor	2 months after storage	4 months after storage	6months after storage	8months after storage	10 months after storage	12 months after storage	14 months after storage
P_1	13.61	12.85	10.72	9.85	8.51	7.88	5.69
P_2	14.66	13.52	13.11	12.59	10.52	9.37	7.87
P_3	13.92	13.88	12.60	10.94	9.44	8.67	7.60
P_4	14.81	14.50	13.88	11.50	6.22	5.21	3.42
P_5	15.07	13.66	13.09	11.25	10.41	11.05	9.20
P_6	14.44	14.30	13.89	11.00	10.23	9.79	8.45
P_7	15.41	14.34	13.04	12.47	11.94	10.13	9.46
P_8	16.34	15.15	14.49	13.16	11.92	10.99	9.52
P_9	16.47	15.58	15.35	14.32	12.18	11.42	10.59
S.Em±	0.20	0.28	0.34	0.27	0.24	0.15	0.13
C.D. at 5%	0.60	0.84	1.01	0.82	0.71	0.44	0.38
CV%	2.35	3.46	4.41	4.00	4.06	2.71	2.77

Table 3: Effect of seed pelleting on seedling dry weight (mg) in onion seeds during storage

Factor	2 months after storage	4 months after storage	6 months after storage	8 months after storage	10 months after storage	12 months after storage	14 months after storage
P_1	25.50	23.47	19.33	17.29	14.50	9.42	4.80
P_2	26.96	24.61	21.83	19.46	14.86	12.69	9.71
P_3	27.09	25.50	22.47	20.35	16.17	13.16	9.55
P_4	28.57	26.54	24.88	21.49	12.60	9.94	3.93
P_5	26.32	24.40	20.67	19.48	17.32	16.60	11.30
P_6	26.06	24.49	20.46	19.32	16.13	15.34	10.61
P_7	29.18	25.76	22.47	21.01	19.30	15.57	11.15
P_8	29.67	27.39	23.58	21.64	19.32	16.30	12.46
P_9	30.10	28.65	25.66	22.73	20.69	17.60	14.64
S.Em±	0.30	0.29	0.23	0.27	0.29	0.31	0.16
C.D. at 5%	0.89	0.86	0.68	0.79	0.87	0.91	0.46
CV%	1.88	1.97	1.78	2.27	3.03	3.78	2.74

Table 4: Effect of seed pelleting on seedling vigour index I in onion seeds during storage

Factor	2 months after storage	4 months after storage	6 months after storage	8 months after storage	10 months after storage	12 months after storage	14 months after storage
P_1	1301.58	1191.43	946.08	852.65	715.36	569.90	387.04
P_2	1416.88	1284.21	1223.28	1145.67	911.53	730.94	579.53
P_3	1336.44	1310.24	1158.78	993.11	821.33	670.96	569.87
P_4	1431.27	1372.26	1307.56	1069.76	326.48	229.09	50.80
P_5	1452.50	1283.97	1217.30	1042.51	932.71	880.00	665.64
P_6	1390.99	1364.19	1301.21	1001.48	910.43	773.54	645.26
P_7	1494.73	1358.55	1212.09	1138.08	1062.80	830.43	709.85
P_8	1601.28	1438.92	1347.52	1210.88	1065.25	916.18	736.30
P_9	1625.44	1495.80	1463.35	1340.99	1099.98	970.02	850.41
S.Em±	21.71	36.01	29.08	29.05	17.62	18.10	14.76
C.D. at 5%	64.51	107.00	86.41	86.32	52.34	53.77	43.84
CV%	2.59	4.64	4.06	4.62	3.50	4.29	4.43

Table 5: Effect of seed pelleting on seedling vigour index II in onion seeds during storage

Factor	2 months after storage	4 months after storage	6 months after storage	8 months after storage	10 months after storage	12 months after storage	14 months after storage
P_1	2439.41	2175.75	1707.40	1498.01	1217.50	680.91	326.59
P_2	2605.91	2337.99	2038.57	1770.95	1287.86	989.63	715.74
P_3	2600.43	2404.57	2067.57	1845.65	1406.54	1017.52	715.89
P_4	2761.59	2512.12	2346.72	1998.62	663.84	437.45	58.95
P_5	2534.97	2293.42	1922.45	1805.06	1553.01	1322.53	817.87
P_6	2511.52	2334.04	1917.77	1757.35	1435.84	1211.67	809.56
P_7	2831.23	2438.46	2089.89	1919.19	1717.99	1276.90	837.07
P_8	2907.74	2602.24	2192.98	1990.68	1725.63	1358.08	963.56
P_9	2969.97	2751.15	2446.20	2129.15	1868.99	1495.59	1176.16
S.Em±	36.35	36.38	45.13	32.88	31.03	27.46	2.40
C.D. at 5%	108.01	108.08	103.10	97.68	92.19	81.58	60.60
CV%	2.35	2.60	3.76	3.07	3.76	4.37	4.94

Conclusion

It can be concluded that among the seed pelleting treatments, seeds pelleted with micronutrient mixture 2 (P_9: Nano phosphorus, potassium, manganese, sulphur, copper, zinc and molybdenum) recorded the maximum germination percentage, seedling length, seedling dry weight**,** seedling vigour index I and seedling vigour index II under cold storage condition after fourteen months of storage, might be due to the presence of active compounds in these micronutrient mixture, that interact synergistically with amino acids, specifically tryptophan, to produce indole-3-acetic acid (IAA) during the germination of seeds, resulting in development in seedling growth. Potential reasons behind the observed improvement and maintenance of high germination rates through the use of a micronutrient mixture linked to the presence of plant secondary metabolites, membrane stabilization, and free radical detoxification facilitated by the mineral elements present in the mixture.

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