RESEARCH ARTICLE Indian Journal of Agricultural Research, Volume 57 Issue 1: 08-15 (February 2023)

Influence of Botanical Seed Pelleting on Storability of Onion (*Allium cepa* L.)

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10.18805/IJARe.A-5571

ABSTRACT

Background: Onion (*Allium cepa* L.) is a major bulbous vegetable as well as condiment of family Alliaceae grown in India, originated in Iran and Pakistan. Seed pelleting is a mechanism of applying various materials to the seed that can enhance the seed quality with respect to physiological, physical and health attributes. Seed deterioration during storage is inevitable process; however seed pelleting can reduce the rate of deterioration. The leaf powders possess antioxidant, fungicidal and insecticidal properties that helps in maintaining the seed quality during storage.

Methods: The present investigation was carried out in the laboratory of Department of Seed Science and Technology, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (HP) during the seasons of 2016-17 and 2017-18. This experiment comprised of pelleted seeds with different botanicals carried out to determine the effect of seed pelleting and storage potential of pelleted seeds.

Result: This experiment comprised of pelleted seeds with different botanicals. In all the treatments gum Arabica (5%) was used as the adhesive except control. The pelleted seeds with different material were stored at ambient conditions for nine months. Highest germination (81.75%), seedling length (11.20 cm), seedling dry weight (1.82 g), seedling vigour index- length (920.33), seedling vigour index- mass (148.90) and speed of germination (26.57) were observed in onion seeds pelleted with *Azadirechta indica* leaf powder + clay and *Melia azadirechta* leaf powder + clay. Among the storage periods, fresh pelleted seed (0 month) showed maximum values with respect to germination (86.50%), seedling length (13.38 cm), seedling dry weight (2.02 g), seedling vigour index- length (1154.50), seedling vigour index- mass (173.52) and speed of germination (29.04). From the present studies, it can be concluded that onion seeds pelleted with *Azadirechta indica* leaf powder + clay and *Melia azadirechta* leaf powder + clay showed significant effects for enhancing seed quality during storage.

Key words: Botanicals, Clay, Gum arabica, Pelleting, Seed quality, Storage.

INTRODUCTION

Onion (*Allium cepa* L.), a member of family Alliaceae, is a monophyletic monocot under the class *Liliales* as classified based on cladistic methodology, genomics and molecular polygenetic relationships (Sharma and Sharma, 2006). Originated in Central Asia, onion is now grown and consumed almost in all parts of the world. Globally, onion production is to the tune of 88.48 and 4.17 million tonnes in respect of fresh and dry onion, respectively from an area of 5.5 million ha during 2014-15 (Anonymous, 2016). In India, onion is grown in an area of 1.27 million ha with a production of 21.56 million metric tonnes having a productivity of 16.98 tonnes per ha during 2016-2017 (Anonymous, 2017). Onion occupies a remarkable place in Indian economy as it occupies 7.4 per cent of total area under vegetables and 5.7 per cent of the total vegetable output in the country. Seed pelleting with leaf powder not only improves the health and physiological quality of seeds and slow down the rate of deterioration (Bashyam, 1999). Seed deterioration during storage is inevitable process; however botanical seed pelleting can reduce the rate of deterioration. The leaf powders possess antioxidant, fungicidal and insecticidal properties that helps in maintaining the seed quality during storage.

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How to cite this article: Panwar, A., Thakur, A.K., Sharma, P., Negi, S., Nalwa, C. and Bisht, A. (2023). Influence of Botanical Seed Pelleting on Storability of Onion (*Allium cepa* L.). Indian Journal of Agricultural Research. 57(1): 8-15. doi: 10.18805/IJARe.A-5571.

Submitted: 04-04-2020 **Accepted:** 04-09-2020 **Online:** 16-12-2020

MATERIALS AND METHODS

The storage experiment was conducted in Laboratory Department of Seed Science and Technology, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (HP) during the *rabi* season 2016-17 and 2017-18. Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (HP) is located at an altitude of 1025 meters above mean sea level with latitude of 30°51′06″N and longitude of 77°10′56″ E in the mid-hill zone of Himachal Pradesh.1183 meters above mean sea level with latitude of 30.5°N and longitude of

77.09°E in the mid hill zone of Himachal Pradesh, India. Climate of the area is generally sub-temperate and semi-humid characterized by cold winters. Generally, December and January months are the coldest while, May and June are the hottest months.

The plant leaves of different botanicals were collected from the university and nearby area. Sun dried leaves made in fine powdered form with the help of grinder. After grinding a fine leaf powder was obtained by sieving through 0.10 mm wire mesh. The filler materials clay was mixed with botanicals powder in definite proportion 1:4 by volume and gum arabica (5%) used as adhesive. Using SATEC EQUIPMENT for seed pelleting.50 g seeds were put in the rotating drum and the combination of filler materials and botanical powders as an inert matter are sprinkled on the seeds and are rolled for effective and uniform coating. The thickness of the pelleted seed was depending on the amount of adhesive in relation to the amount of seed. So that pelleting mixture was coated on to the seed uniformly in required proportion. After pelleting pelleted seeds were air dried under the shade for two days. The observations on germination percentage were calculated as per the ISTA procedure (Anonymous, 1999). Root length, shoot length seedling length and seedling vigour index I and II were calculated as per the procedures of the Abdul Baki and Anderson (1973).

SV I-I= Germination percentage × Seedling length in cms

SV I-II= Germination percentage × Seedling dry weight in mg.

Treatments details

Factor 1: Storage duration.

Storage duration	Symbol used
0 Month	S1
3 Month	S2
6 Month	S3
9 Month	S4

Factor 2: Seed pelleting.

Pelleting	Symbol used	Common name
Acorus calamus + clay	P1	Bach
Vitex negendu + clay	P2	Bana
Melia azadirechta + clay	P3	Darek
Albezia chinensis + clay	P4	Chugi
Adhatoda vasica + clay	P5	Basuti
Tegetus species + clay	P6	Wild Genda
Artemesia roxburghiana + clay	P7	Chamber
Lantana camara + clay	P8	Phool Lakdi
Eucalyptus species + clay	P9	Eucalyptus
Azadirechta indica + clay	P10	Neem
Cinnamomum camphora + clay	P11	Camphor
Cymbopogan flexuosus + clay	P12	Lemon Grass
Clay	P13	
Control (unpelleted)	P14	

*Gum Arabica shall be used as adhesive in all treatments except control.

RESULTS AND DISCUSSION

Germination

Germination is a complex critical character under marginal environmental conditions. It is one of the important criteria for determining the physiological aspect of seed and gives an idea about the ability of seed to produce normal and healthy seedling under the field conditions. During seed germination, various stored substrates are reactivated, repaired, transformed into new building materials necessary for the initial growth of embryo, its subsequent growth and seedling establishment in its natural habitat Koller and Hadas (1982). A perusal of data presented in Table 1 indicated that different pelleting materials and storage periods and their interactions showed a significant effect on germination. The highest germination (81.75%) was recorded with *Azadirechta indica* leaf powder pellletd seed (P_{10}), which was at par with *Melia azadirechta* leaf powder (P_3) pelleted seed (81.35%) and the lowest germination (61.58%) was recorded in unpelleted seed (P_{14}). Among the storage durations the highest germination (79.11%) was found in fresh pelleted seeds (S_1) *i.e.* 0 month storage duration while the lowest germination (69.22%) was recorded in (S_4) *i.e.* 9 month storage duration. Interaction effect revealed that treatment combination $P_{10} \times S_1$ *i.e.* Fresh pelleted seeds with *Azadirechta indica* leaf powder resulted in the highest germination (86.40%). However, the lowest germination (54.58%) was recorded in the treatment combination $P_{14} \times S_4$ *i.e.* unpelleted seed during 9 months of storage duration.

The possible reason for the higher germination of botanical leaf powder pelleted seed may be due to greater hydration of colloids and higher viscosity of protoplasm and cell membrane that allows the early entrance of moisture that activated the early hydrolysis of reserve food materials in the seed as compared to untreated seeds. These bio contents might have synergistically interacted with amino acids especially tryptophan to form the indole acetic acid (IAA) in germinating seeds to bring about enhancement in seedling growth (Lu *et al.,* 1983).

The enhanced germination due to pelleting has been reported by Prakash *et al.* (2018) in black gram seed pelleted with pungum leaf powder. Similar results of enhanced germination due to pelleting of seeds with different leaf powders have been found in chilli (Jerlin *et al.,* 2008), red gram (Anbarsan *et al.,* 2016) and okra (Rameshkumar and Muthukrishnan 2015).

Seedling length

Seedling length has direct correlation with seed vigour during the germination process, the seed which produce taller seedling are considered to be more vigorous than those which produce shorter seedling. A perusal of data presented in Table 2 indicated that different pelleting materials and storage periods and their interactions showed a significant effect on seedling length of onion cv. Palam Lohit. Maximum seedling length (11.20 cm) was recorded with

Table 1: Effect of seed pelleting and storage period on germination percentage in onion cv. Palam Lohit.

Storage	Year 2016-17					Year 2017-18					Pooled				
pelleting	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
P_1	81.56	79.33	74.11	71.46	76.62	82.91	80.45	76.75	72.75	78.22	82.24	79.89	75.43	72.11	77.42
	(9.09)	(9.19)	(9.30)	(8.74)	(9.08)	(9.16)	(9.22)	(9.35)	(8.85)	(9.14)	(9.09)	(9.19)	(9.30)	(8.74)	(9.08)
P_2	83.48	80.46	76.67	74.36	78.74	84.02	81.56	78.29	75.34	79.80	83.75	81.01	77.48	74.85	79.27
	(9.12)	(9.20)	(9.03)	(8.67)	(9.01)	(9.18)	(9.25)	(9.00)	(8.72)	(9.04)	(9.12)	(9.20)	(9.03)	(8.67)	(9.01)
P_3	85.56	82.25	78.79	76.35	80.74	86.38	83.34	80.48	77.68	81.97	85.97	82.80	79.64	77.02	81.35
	(8.70)	(9.34)	(8.67)	(9.01)	(8.93)	(8.71)	(9.36)	(8.68)	(9.02)	(8.94)	(8.70)	(9.34)	(8.67)	(9.01)	(8.93)
P_4	75.47	72.76	68.35	67.31	70.97	77.25	74.45	70.54	68.29	72.63	76.36	73.61	69.45	67.80	71.80
	(8.48)	(8.41)	(8.96)	(9.03)	(8.72)	(8.51)	(8.49)	(9.03)	(9.09)	(8.78)	(8.48)	(8.41)	(8.96)	(9.03)	(8.72)
P_5	82.27	79.10	76.56	72.23	77.54	83.35	80.67	79.56	72.34	78.98	82.81	79.89	78.06	72.29	78.26
	(9.12)	(8.59)	(8.95)	(9.03)	(8.92)	(9.18)	(8.69)	(9.04)	(9.09)	(9.00)	(9.12)	(8.59)	(8.95)	(9.03)	(8.92)
P_6	83.67	80.45	76.78	73.12	78.51	84.58	81.56	79.67	73.43	79.81	84.13	81.01	78.23	73.28	79.16
	(8.69)	(8.44)	(8.38)	(9.19)	(8.67)	(8.79)	(8.58)	(8.51)	(9.14)	(8.76)	(8.69)	(8.44)	(8.38)	(9.19)	(8.67)
P_7	80.46	74.46	71.45	70.56	74.23	80.01	76.28	72.34	70.29	74.73	80.24	75.37	71.90	70.43	74.48
	(8.44)	(8.91)	(8.02)	(7.96)	(8.33)	(8.52)	(8.79)	(8.08)	(8.05)	(8.36)	(8.44)	(8.91)	(8.02)	(7.96)	(8.33)
P_8	74.23	70.25	69.89	67.14	70.38	75.08	72.64	70.49	68.56	71.69	74.66	71.45	70.19	67.85	71.04
	(8.67)	(8.81)	(8.93)	(8.33)	(8.69)	(8.82)	(8.90)	(9.03)	(8.46)	(8.80)	(8.67)	(8.81)	(8.93)	(8.33)	(8.69)
P_9	74.76	69.25	67.25	65.23	69.12	74.95	71.43	68.23	66.45	70.27	74.86	70.34	67.74	65.84	69.69
	(8.81)	(8.82)	(8.51)	(8.42)	(8.64)	(8.98)	(8.98)	(8.56)	(8.46)	(8.74)	(8.81)	(8.82)	(8.51)	(8.42)	(8.64)
P_{10}	86.23	83.45	79.53	77.57	81.70	86.57	82.53	79.43	78.67	81.80	86.40	82.99	79.48	78.12	81.75
	(8.26)	(8.97)	(8.33)	(8.44)	(8.50)	(8.32)	(8.97)	(8.41)	(8.58)	(8.57)	(8.26)	(8.97)	(8.33)	(8.44)	(8.50)
P_{11}	74.18	70.25	68.44	66.34	69.80	74.34	71.64	69.69	67.45	70.78	74.26	70.95	69.07	66.90	70.29
	(7.94)	(7.67)	(8.51)	(8.68)	(8.20)	(8.00)	(7.72)	(8.59)	(8.74)	(8.26)	(7.94)	(7.67)	(8.51)	(8.68)	(8.20)
P_{12}	80.19	78.35	70.26	69.21	74.50	80.38	76.34	72.56	70.42	74.93	80.29	77.35	71.41	69.82	74.71
	(8.80)	(8.26)	(8.56)	(8.61)	(8.56)	(8.87)	(8.32)	(8.56)	(8.63)	(8.60)	(8.80)	(8.26)	(8.56)	(8.61)	(8.56)
P_{13}	70.98	63.25	61.98	58.12	63.58	71.42	64.34	62.98	58.32	64.27	71.20	63.80	62.48	58.22	63.92
	(8.46)	(8.25)	(8.14)	(8.68)	(8.43)	(8.44)	(8.34)	(8.21)	(8.93)	(8.48)	(8.46)	(8.25)	(8.14)	(8.86)	(8.43)
P_{14}	69.75	62.34	57.87	54.35	61.08	71.08	63.78	58.67	54.81	62.09	70.42	63.06	58.27	54.58	61.58
	(8.21)	(8.38)	(7.69)	(7.44)	(7.93)	(8.27)	(8.45)	(7.70)	(7.47)	(7.97)	(8.21)	(8.38)	(7.69)	(7.44)	(7.93)
Mean	78.77	74.71	71.28	68.81	73.39	79.45	75.79	72.83	69.63	74.43	79.11	75.25	72.06	69.22	73.91
	(8.63)	(8.66)	(8.57)	(8.60)	(8.61)	(8.70)	(8.72)	(8.63)	(8.66)	(8.67)	(8.63)	(8.66)	(8.57)	(8.60)	(8.67)

Figures in the parenthesis are square root transformed.

$CD_{0.05}$

	2016-17	2017-18		Pooled
P	1.61	1.58	P	0.848
S	0.86	0.85	S	0.600
S×P	3.21	3.17	S×P	2.244
			Y	NS
			Y×P	NS
			Y×S	1.122
			Y×S×P	NS

Table 2: Effect of seed pelleting and storage period on seedling length (cm) in onion cv. Palam Lohit.

Storage pelleting	Year 2016-17					Year 2017-18					Pooled				
period	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
P_1	12.23	11.10	9.45	7.11	9.97	12.86	11.17	9.63	7.14	10.20	12.55	11.14	9.54	7.13	10.09
P_2	10.56	10.31	8.67	7.00	9.14	11.73	10.23	9.38	7.10	9.61	11.15	10.27	9.03	7.05	9.37
P_3	13.22	11.57	10.11	9.14	11.01	13.54	11.89	10.34	9.29	11.27	13.38	11.73	10.23	9.22	11.14
P_4	9.98	9.23	7.89	6.65	8.44	10.83	9.18	8.27	6.45	8.68	10.41	9.21	8.08	6.55	8.56
P_5	10.89	9.89	8.95	7.21	9.24	11.24	10.47	9.21	7.46	9.60	11.07	10.18	9.08	7.34	9.42
P_6	11.78	11.12	9.11	7.12	9.78	12.03	11.56	9.45	7.37	10.10	11.91	11.34	9.28	7.25	9.94
P_7	10.03	8.78	7.86	7.06	8.43	10.34	9.10	8.24	7.12	8.70	10.18	8.94	8.05	7.09	8.57
P_8	11.00	9.67	8.24	6.89	8.95	11.11	10.10	8.22	7.38	9.20	11.06	9.89	8.23	7.14	9.08
P_9	10.12	8.93	8.45	6.56	8.52	10.23	9.45	8.38	6.68	8.69	10.18	9.19	8.42	6.62	8.60
P_{10}	13.27	11.47	9.98	9.39	11.03	13.46	11.94	10.68	9.42	11.38	13.37	11.71	10.33	9.41	11.20
P_{11}	10.89	8.78	8.34	7.13	8.79	10.69	9.30	8.23	7.33	8.89	10.79	9.04	8.29	7.23	8.84
P_{12}	11.23	8.97	7.67	7.35	8.81	11.36	9.70	8.10	7.46	9.16	11.30	9.34	7.89	7.41	8.98
P_{13}	8.74	7.15	6.21	5.42	6.88	9.03	7.45	6.37	5.87	7.18	8.89	7.30	6.29	5.65	7.03
P_{14}	8.12	7.00	6.17	5.19	6.62	8.34	7.10	6.21	5.23	6.72	8.23	7.05	6.19	5.21	6.67
Mean	10.86	9.57	8.36	7.09	8.97	11.20	9.90	8.62	7.24	9.24	11.03	9.74	8.49	7.16	9.11

$CD_{0.05}$

	2016-17	2017-18		Pooled
P	0.176	0.212	P	0.104
S	0.094	0.113	S	0.073
S×P	0.352	0.424	P×S	0.274
			Y	NS
			Y×P	NS
			Y×S	0.137
			Y×S×P	0.387

Table 3: Effect of seed pelleting and storage period on seedling dry weight (mg) in onion cv. Palam Lohit.

Storage period	Year 2016-17					Year 2017-18					Pooled				
pelleting	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
P_1	1.49	1.47	1.30	1.25	1.38	1.79	1.53	1.32	1.27	1.48	1.64	1.50	1.31	1.26	1.43
P_2	1.52	1.49	1.26	1.22	1.37	1.56	1.46	1.36	1.24	1.41	1.54	1.48	1.31	1.23	1.39
P_3	2.02	1.84	1.84	1.55	1.81	2.01	1.88	1.85	1.59	1.83	2.02	1.86	1.84	1.57	1.82
P_4	1.57	1.45	1.44	1.27	1.43	1.58	1.47	1.45	1.29	1.45	1.58	1.46	1.44	1.28	1.44
P_5	1.79	1.62	1.61	1.36	1.60	1.78	1.63	1.61	1.39	1.60	1.79	1.63	1.61	1.38	1.60
P_6	1.75	1.61	1.60	1.41	1.59	1.80	1.62	1.60	1.41	1.61	1.78	1.62	1.60	1.41	1.60
P_7	1.65	1.58	1.54	1.35	1.53	1.72	1.57	1.55	1.37	1.55	1.69	1.58	1.54	1.36	1.54
P_8	1.51	1.31	1.28	1.15	1.31	1.53	1.30	1.25	1.17	1.31	1.52	1.31	1.27	1.16	1.31
P_9	1.55	1.38	1.35	1.16	1.36	1.54	1.37	1.35	1.16	1.36	1.55	1.38	1.35	1.16	1.36
P_{10}	2.01	1.85	1.84	1.55	1.81	2.01	1.86	1.81	1.58	1.82	2.01	1.86	1.83	1.57	1.81
P_{11}	1.56	1.41	1.39	1.17	1.38	1.59	1.41	1.39	1.18	1.39	1.58	1.41	1.39	1.18	1.39
P_{12}	1.72	1.61	1.59	1.34	1.56	1.73	1.62	1.59	1.40	1.59	1.73	1.61	1.59	1.37	1.57
P_{13}	1.35	1.29	1.23	1.11	1.25	1.41	1.32	1.27	1.13	1.28	1.38	1.31	1.25	1.12	1.26
P_{14}	1.28	1.14	1.13	1.10	1.16	1.32	1.20	1.17	1.10	1.20	1.30	1.17	1.15	1.10	1.18
Mean	1.63	1.50	1.46	1.29	1.47	1.67	1.52	1.47	1.31	1.49	1.65	1.51	1.46	1.30	1.48

$CD_{0.05}$

	2016-17	2017-18		Pooled
P	0.0299	0.0288	P	0.016
S	0.0160	0.0154	S	0.011
S×P	0.0598	0.0576	P×S	0.041
			Y	NS
			Y×P	0.029
			Y×S	0.021
			Y×S×P	0.058

Table 4: Effect of seed pelleting and storage period on seed vigour index - length in onion cv. Palam Lohit.

Storage period	Year 2016-17					Year 2017-18					Pooled				
pelleting	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
P_1	997.50	880.76	700.03	508.21	771.62	1066.02	898.64	738.76	519.93	805.84	1031.76	889.70	719.40	514.07	788.73
P_2	892.16	846.65	679.23	527.79	736.46	989.47	837.75	737.63	534.98	774.96	940.82	842.20	708.43	531.38	755.71
P_3	1140.70	959.08	800.02	703.97	900.94	1160.91	979.22	825.38	724.75	922.56	1150.81	969.15	812.70	714.36	911.75
P_4	753.22	671.71	539.28	447.90	603.03	835.96	683.46	583.35	440.38	635.79	794.59	677.59	561.32	444.14	619.41
P_5	910.45	782.08	685.12	520.99	724.66	936.69	844.60	733.22	539.64	763.54	923.57	813.34	709.17	530.32	744.10
P_6	1009.23	902.06	705.37	525.35	785.50	1025.28	942.92	753.12	541.29	815.65	1017.26	922.49	729.25	533.32	800.58
P_7	806.66	653.77	561.62	498.13	630.04	827.29	694.24	596.04	500.46	654.51	816.98	674.00	578.83	499.29	642.28
P_8	817.12	679.30	576.03	462.55	633.75	834.16	733.75	579.42	505.89	663.31	825.64	706.53	577.72	484.22	648.53
P_9	756.57	618.53	568.27	427.89	592.82	766.76	675.30	572.00	443.88	614.49	761.66	646.92	570.14	435.89	603.65
P_{10}	1144.21	956.93	793.48	728.38	905.75	1164.80	985.28	848.69	740.85	934.91	1154.50	971.10	821.09	734.62	920.33
P_{11}	807.73	616.93	570.79	473.07	617.13	794.70	666.22	573.87	494.54	632.33	801.21	641.58	572.33	483.80	624.73
P_{12}	900.51	702.20	538.87	508.68	662.56	913.65	740.76	587.54	525.31	691.82	907.08	721.48	563.20	517.00	677.19
P_{13}	620.74	452.28	384.89	314.84	443.19	644.97	479.38	401.18	342.29	466.95	632.85	465.83	393.03	328.57	455.07
P_{14}	566.40	436.44	356.81	282.10	410.44	592.83	453.18	364.47	286.54	424.25	579.61	444.81	360.64	284.32	417.35
Mean	865.94	725.62	604.27	494.99	672.71	896.68	758.19	635.33	510.05	700.06	881.31	741.91	619.80	502.52	686.39

$CD_{0.05}$

	2016-17	2017-18		Pooled
P	19.12	22.36	P	11.060
S	10.22	11.95	S	7.821
S×P	38.24	44.72	P×S	29.262
			Y	NS
			Y×P	NS
			Y×S	NS
			Y×S×P	NS

Azadirechta indica leaf powder pelleted seed (P_{10}) which was at par with *Melia azadirechta* leaf powder (P_3) pelleted seed (11.14 cm), while the lowest seedling length (6.67 cm) was recorded in unpelleted seed (P_{14}). Among storage duration, fresh pelleted seeds (S_1) resulted into highest seedling length (11.03 cm) and lowest seedling length (7.16 cm) was recorded in 9 months storage duration (S_4). Interaction effects revealed that treatment combination $P_3 \times S_1$ *i.e.* fresh *Melia azadirechta* leaf powder pelleted seed resulted in longest seedling (13.38 cm). However, smallest seedling (5.21 cm) was recorded in treatment combination $P_{14} \times S_4$ *i.e.* unpelleted seed stored for 9 months.

Increase in seedling length of seedlings raised through botanical leaf powder pelleted seeds may be due to activation of the growth promoting substances and translocations of secondary metabolites to the growing seedling. Similar results have been reported in black gram by Prakash *et al.* (2018), in okra and chilli by Ramesh Kumar and Muthukrishnan (2015) and in brinjal by Satish Kumar *et al.* (2014). These studies also revealed that there is control of physiological deterioration of seeds by antifungal and antioxidant effect of leaf powders and efficient translocation of nutrients from seed into the initially heterotrophic seedling.

Seedling dry weight

Seedling dry weight is an important character as it is directly correlated to seed vigour. Seed lot having higher seedling dry weight considered to have higher vigour (Raturi, 2013). An appraisal of data presented in Table 3 showed that different pelleting materials and storage periods and their interactions showed a significant effect on seedling dry weight of onion cv. Palam Lohit. Pooled data revealed significant effects of different pelleting materials and storage periods on the seedling dry weight of onion cv. Palam Lohit. Maximum seedling dry weight (1.82 mg) was recorded with *Melia azadirechta* leaf powder (P_3) pelleting which was at par with *Azadirechta indica* leaf powder (P_{10}) pelleted seed (1.81 mg) and the lowest seedling dry weight (1.18 mg) was recorded in the unpelleted seed (P_{14}). Amongst the storage durations, the highest seedling dry weight (1.65 mg) was found in S_1 storage duration (0 month *i.e.* fresh seeds) and lowest seedling dry weight (1.30 mg) in S_4 *i.e.* 9 months storage duration. Interaction effect revealed that treatment combination $P_3 \times S_1$ *i.e.* Fresh pelleted *Melia azadirechta* leaf powder seed resulted in the highest seedling dry weight (2.02 mg). However, the lowest seedling dry weight (1.10 mg) was recorded in the treatment combination $P_{14} \times S_4$ *i.e.* unpelleted seed stored for 9 months.

Seedling dry weight is an important attribute which determines vigour of the seedling. Bolder seeds produce healthy seedling and have more dry weight than that of the small seeds. Plants grown in the favorable conditions produce healthy and bold seeds which in turn resulted in higher dry weight. The botanical leaf powders contain auxin like substance which enhances the development of root and shoot of seedling in pelleted seeds. These enhanced metabolic activities lead to earliness in germination and seedling growth resulting in higher seedling dry weight. A study was carried out by Prakash *et al.* (2018) revealed that the highest seedling dry weight was found in black gram seed pelleted with pungum leaf powder. Rameshkumar and Muthukrishnan (2015) also reported that in okra and chilli pepper seed pelleted with *Annona squamosa* leaf powder resulted in increase in the seedling dry weight. In mustard, the enhanced seedling dry weight due to seed pelleting with leaf powder *Propis julifora* was observed by Geetha and Krishnaswami (2011).

Seed vigour index- length

Vigour is a qualitative term encompassing the sum of those properties of the seed which determine the potential level of activity and performance of seed or seed lot during germination and seedling emergence (Perry, 1984). Analysis of variance indicated significant variations in the effect of different pelleting materials and storage periods and their interactions showed a significant effect on seed vigour index-length of onion cv. Palam Lohit. Pooled data revealed a significant effect of different pelleting materials and storage periods on the seed vigour index-I of onion cv. Palam Lohit (Table 4). Maximum seed vigour index-I (920.33) was recorded with *Azadirechta indica* leaf powder (P_{10}) which was on par with *Melia azadirechta* leaf powder (P_3) pelleted seed (911.75) and the lowest seed vigour index-I (417.35) was recorded in the unpelleted seed (P_{14}). Among the storage durations, S_1 *i.e.* 0 month storage duration resulted into the highest seed vigour index-I (881.31) and lowest seed vigour index-I (502.52) was recorded in S_4 *i.e.* 9 months storage duration. Interaction effects revealed that treatment combination $P_{10} \times S_1$ *i.e.* fresh *Azadirechta indica* leaf powder pelleted seeds recorded the highest seed vigour index-I (1154.50). However, the lowest seed vigour index-length (284.32) was recorded in the treatment combination $P_{14} \times S_4$ *i.e.* unpelleted seed stored up to 9 months.

The germination test alone is not enough to provide information about the performance of seed under the field conditions. So, the vigour status of the seed becomes an important parameter as it determines the actual performance of seed under the field conditions. Prakash *et al.* (2018) pelleted black gram seed with pungum leaf powder and observed enhanced seed vigour compared to other treatments of seed pelleting. Similar finding of increase in SV-I has been reported in red gram (Anbarsan *et al.*, 2016), tomato (Shashibhasker *et al.,* 2011; Rameshkumar and Muthukrishnan, 2015), okra (Geetha and Krishnasamy, 2011) and French bean (Babu *et al.*, 2005).

SUMMARY AND CONCLUSION

This experiment comprised of pelleted seeds with *Acorus calamus* leaf powder + clay, *Vitex negendu* leaf powder + clay, *Melia azadirechta* leaf powder + clay, *Albezia chinensis* leaf powder + clay, *Adhatoda vasica* leaf powder + clay, *Tegetus* species leaf powder + clay, *Artemesia roxburghiana* leaf powder + clay, *Lantana camara* leaf powder + clay, *Eucalyptus* species leaf powder + clay,

Azadirechta indica leaf powder + clay, *Cinnamomum camphora* leaf powder + clay, *Cymbopogan flexuosus* leaf powder + clay, clay, unpelleted seed (control). In all the treatments gum arabica was used as the adhesive except control. The pelleted seeds with different material were stored at ambient conditions for 9 months. The seed quality parameters were studied immediately after seed pelleting, three months, six months and nine months of storage. The observations were recorded in between paper method for evaluating the germination, seedling length, seedling dry weight, seedling vigour index-II and seedling vigour index-I, whereas speed of germination was recorded by top on paper method. The analysis of variance depicted that there were significant differences among various treatments at 1% level of significance.

Highest germination (81.75%), seedling length (11.20 cm), seedling dry weight (1.82 g), seedling vigour index-I (920.33), seedling vigour index-II (148.90) and speed of germination (26.57) were observed in onion seeds pelleted with *Azadirechta indica* leaf powder + clay followed by *Melia azadirechta* leaf powder + clay.

Among the storage periods, fresh pelleted seed (0 month) showed maximum values with respect to germination (86.50%), seedling length (13.38 cm), seedling dry weight (2.02 g), seedling vigour index-I (1154.50), seedling vigour index-II (173.52) and speed of germination (29.04).

ACKNOWLEDGEMENT

The authors wish to acknowledge the Head of Department of Seed Science and Technology, Dr. YS Parmar University of Horticulture and Forestry, Solan (Nauni) HP for the facilities given at the time of investigation.

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