Influence of different doses of nitrogen on shelf-life of different potato (*Solanum tubersoum* L.) cultivars

ABSTRACT

The shelf life of different potato cultivars was investigated under the influence of different doses of nitrogen along with control. The experiment was carried out at the Research Farm of the Department of Vegetable Science, CCS Haryana Agricultural University, Hisar during the *rabi* season of 2019-20. The treatments consisted of four doses of nitrogen (0, 80, 160, and 240 kg ha^{-1}) and three potato cultivars *viz.*, Kufri Pukhraj, Kufri Gaurav and AICRP-P-39. After harvesting potatoes from the field, the tubers were cleaned and stored using a completely randomized design in a well-ventilated room for three months to assess their shelf life. The field application of 240 kg nitrogen per hectare resulted in the poor shelf life of tubers as compared to the ones grown under lower doses. However, the superior shelf life of potato tubers was observed under control during the whole storage period. Among the cultivars, Kufri Pukhraj had better keeping quality than Kufri Gaurav and AICRP-P-39.

Keywords: Cultivar, nitrogen, potato, shelf life, tuber

1. INTRODUCTION

Potato (*Solanum tuberosum*) is the major food crop after wheat and rice, and it is grown in over 150 countries throughout the world [1]. India, the world's second-largest potato producer after China, produces 50.19 million MT tubers yearly over 2.17 million hectares, with an average productivity of 23.1 MT ha^{-1} [2]. The crop may be cultivated in nearly every state and under a wide range of conditions. The states of UP, West Bengal, and Bihar account for about 75% of total potato acreage and 80% of total production. In India, the per capita availability of potato is 17.7 kg, which is about a third of the global average. The potato is known as the "King of Vegetables" and is a high-valued vegetable crop in Haryana. It is primarily grown in Ambala, Panchkula, Yamunanagar, Kurukshetra, Hisar, and Karnal districts of Haryana. Potato, as a highly nutritive crop, necessitates the optimal concentration of essential plant nutrients for effective crop production. Nitrogen is the most vital and limiting nutrient for potato crop growth and development among the many key nutrients. In plants, it has a role in the structure and configuration of nucleic acids, proteins, free amino acids, and enzymes. Apart from its role in protein production, nitrogen is an essential component of the chlorophyll molecule. Potato tubers are indeed the crop's most valuable and nutrient-dense organ. Due to its perishability, tubers should be sold and consumed as soon as possible after harvest. Too much time in the marketing process might result in significant losses for both farmers and consumers. To avoid this, potato tubers must be stored in order to keep a consistent supply in the market. This necessitates the monitoring of tuber quality at harvest as well as in storage. Many factors influence the storage behaviour of potato tubers. Weight loss and chemical composition of stored tubers is influenced by meteorological variables, physiological age of the seed tuber, cultivated variety, and soil type during the growth period, as well as agronomic factors such as leaf withering before maturity and harvest date [3]. Agronomic measures like as fertilizer application influence tuber yield and quality after harvest, and should be maximised, since too low or too high fertilizer application can reduce tuber shelf life [4].

Studies conducted by [5] showed a positive correlation between storage period and degradation in the quality of tubers. [6] reported variation in the performance of different genotypes during the storage period. Sprouting of potato tubers caused some undesirable changes in the tuber quality such as weight loss, shrinkage and loss of nutritive value [7]. Keeping in view the above stated points, the

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experiment was conducted to assess the effect of different doses of nitrogen on shelf life of different potato cultivar, *viz.*, Kufri Pukhraj, Kufri Gaurav and AICRP-P-39.

2. MATERIALS AND METHODS

This investigation was carried out at Post-harvest laboratory of the Department of Vegetable Science, CCS Haryana Agricultural University, Hisar (29°09'N and 75°43'E, elevation 215 m) during the *rabi* season of 2019-20. The soil of the experimental site was sandy loam with approximately 0.48 organic carbon and pH 7.6. The treatments comprised of three potato cultivars *viz*., Kufri Pukhraj, Kufri Gaurav and AICRP-P-39 and four doses of nitrogen (0, 80, 160 and 240 kg ha^{-1}). The experiment was laid out in a completely randomized design (factorial) with three replications. The crop was planted on 23rd October, 2019. All the recommended package of practices was followed uniformly as per the crop requirements with irrigation. Nitrogen was applied in the form of urea fertilizer at 35 DAP. Potato tubers were harvested manually on 21 Feb, 2020. Thereafter, on 5 Mar, 2019, three kg of healthy clean tubers were placed in the post-harvest laboratory from each treatment for three months. Different parameters were recorded during the storage period such as physiological loss in weight (%), decay loss (%) and sprouting (%). The physiological loss in weight of tubers was calculated every 15 days for three months by weighing five randomly marked tubers from each replication. The data was recorded after every 15 days on percent loss due to decay in tubers and percent sprouting was calculated from tubers having sprouts more than 2 mm. Statistical analysis of experimental data was conducted using the OPSTAT software package.

3. RESULTS AND DISCUSSION

Physiological loss in weight (%):

The data on physiological loss in weight were recorded at an interval of 15 days during storage period of 90 days and expressed as cumulative percentage (Table 1). The physiological loss in weight increased considerably with the increase in storage period from starting to the end of experiment. The storage of potato tubers at ambient room temperature during hot summer months leads to severe loss in their quality and weight. The results are in conformity with the results of [8]. The physiological loss in weight of tubers of all tested cultivars increased with increasing doses of nitrogenous fertilizer. The maximum value for cumulative physiological loss in weight was observed with the nitrogen dose of 240 kg ha^{-1} (29.46%), followed by 160 kg ha^{-1} (25.18%) and the minimum under control (16.10%). This might be due to higher transpiration losses, membrane permeability, delay in periderm formation, change in specific gravity, organic acid contents and sugars & amino acids may also, in part, have contributed to the weight loss. Similar results were reported by [9], [10], [11] and [12]. The potato cultivars differed significantly with respect to physiological loss in weight. Among the potato cultivars, the cv. Kufri Pukhraj showed the minimum cumulative physiological loss in weight (20.41%) in comparison to Kufri Gaurav (22.64%) and AICRP-P-39 (24.22%) on 90th day of storage under ambient conditions. These results are in accordance with the findings of [13]. This variation among cultivars with reference to physiological loss in weight might be attributed to the genetic factors [14]. The interaction of different nitrogen doses and cultivar for all the treatments differed significantly

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Decay loss (%):

The data on decay loss (%) were recorded at an interval of 15 days during storage period of 90 days and expressed as cumulative percentage (Table 1). The decay loss of tubers increased with storage period, *i.e.*, more decay was noticed at the end of storage study as compared to start and mid of the experiment. The decay loss might be due to susceptibility of potato tubers to different disease causing organisms and the pests attack during storage, which got enough time to multiply with increasing storage period. The decay loss in tubers of all tested cultivars increased with increasing nitrogen doses. The maximum decay loss was observed with the nitrogen dose of 240 kg ha^{-1} (15.93%), followed by 160 kg ha^{-1} (14.19%) and the minimum under control (11.39%) at the end of experiment. This might be due to tuber harvested from the treatment having higher nitrogen level causing susceptibility to shrivelling and moisture loss resulting in more rotting. Similar results were reported by [15]. Among the cultivars, significant difference was noticed for decay loss throughout the storage study. The cv. Kufri Pukhraj showed the minimum decay loss (12.56%) in comparison to Kufri Gaurav (13.58%) and AICRP-P-39 (14.27%) on 90th day of storage under ambient conditions. This difference can be attributed to genetic variation among the cultivars. Similar variation was also noticed in the experiments conducted by [5] and [7]. The interaction of different nitrogen doses and cultivars for all the treatments differed significantly.

Sprouting (%):

Sprouting in tubers during storage degrades their nutritive value and marketability (Brar and Rana 2016). The sprouting percentage increased with storage period, *i.e.*, storing tubers for long period leads to more sprouting in tubers (Table 2). This might be due to release of dormancy in tubers with time. The results are in conformity with the findings of [16]. The sprouting percentage in tubers of all tested cultivars increased with increasing nitrogen doses. The maximum sprouting % was observed with the nitrogen dose of 240 kg ha^{-1} (11.62, 35.96 and 66.71%), followed by 160 kg ha^{-1} (10.22, 33.76 and 62.07%) and the minimum under control (8.08, 28.65 and 55.14%) at the 30th, 60th and 90th day of storage period. This might be due to more weight loss occurring from higher doses of nitrogen, as sprouting is closely associated with weight loss in tubers [17]. The results of present investigation are in line with the findings of [18]. Among the cultivars, significant difference was noticed for sprouting percentage. The cv. Kufri Gaurav showed significantly maximum cumulative sprouting % (11.00, 33.55 and 62.73%) followed by AICRP-P-39 (9.39, 32.43 and 61.10%), while Kufri Pukhraj showed the minimum cumulative sprouting % (8.12, 30.90 and 57.25%) at 30th, 60th and 90th day of storage, respectively. The results confirm the findings of [6], [7] and [16]. The interaction between nitrogen doses and cultivars for sprouting (%) was found significant for all the treatment combinations.

4. CONCLUSION

The shelf life of tubers gets considerably shortened when nitrogen dose increased. The storability of potato tubers was better at nitrogen application rate of 0 kg ha^{-1} compared to 80, 160, and 240 kg ha^{-1}. Also, among the cultivars, the cv. Kufri Pukhraj performed superior to Kufri Gaurav and AICRP-P-39 for most of the characters studied. Based on the results, it can be concluded that potato tubers of the cv. Kufri Pukhraj supplied with 0 kg N/ha could be stored longer than other treatment combinations with minimum post-harvest quality loss.

5. REFERENCES

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Table 1: Effect of nitrogen doses on physiological loss in weight (%) and decay loss (%) of tubers of different potato cultivars during storage under ambient conditions

N doses (kg ha^{-1})	Cultivars	Decay loss (%)						Physiological loss in weight (%)					
		Storage period (days)											
		15	30	45	60	75	90	15	30	45	60	75	90
0 (N_0)	K. Pukhraj (V_1)	0.00	0.00	0.00(0.07)	1.89	5.78	10.44	2.20	4.91	5.56	8.53	11.96	14.78
	K. Gaurav (V_2)	0.00	0.00	0.00(0.10)	2.95	6.65	11.52	2.62	5.45	6.15	9.41	13.39	16.57
	AICRP-P-39 (V_3)	0.00	0.00	0.00(0.17)	3.14	6.90	12.21	2.83	5.90	6.65	10.21	14.38	16.95
Mean of N_0		0.00	0.00	0.00(0.11)	2.66	6.44	11.39	2.55	5.42	6.12	9.35	13.24	16.10
80 (N_1)	K. Pukhraj (V_1)	0.00	0.00	0.00(0.15)	2.66	6.24	10.86	3.83	7.01	8.22	10.62	12.76	16.67
	K. Gaurav (V_2)	0.00	0.00	0.00(0.18)	3.54	7.72	12.63	4.07	7.44	10.03	11.36	13.31	19.62
	AICRP-P-39 (V_3)	0.00	0.00	0.00(0.30)	4.10	8.45	13.55	4.40	8.17	11.09	12.22	16.18	20.59
Mean of N_1		0.00	0.00	0.00(0.21)	3.43	7.47	12.35	4.10	7.54	9.78	11.38	14.08	18.96
160 (N_2)	K. Pukhraj (V_1)	0.00	0.00	0.01(0.51)	3.87	8.13	13.48	6.25	10.96	13.34	15.08	18.77	22.81
	K. Gaurav (V_2)	0.00	0.00	1.16(6.11)	4.56	8.70	14.18	7.00	11.67	14.11	17.07	22.28	25.31
	AICRP-P-39 (V_3)	0.00	0.00	1.34(6.56)	4.75	9.13	14.92	7.52	12.62	15.44	17.57	24.11	27.42
Mean of N_2		0.00	0.00	0.84(4.39)	4.39	8.65	14.19	6.92	11.75	14.30	16.00	21.72	25.18
240 (N_3)	K. Pukhraj (V_1)	0.00	0.00	1.25(6.42)	5.22	9.11	15.45	7.39	11.44	15.23	17.64	22.87	27.40
	K. Gaurav (V_2)	0.00	0.00	2.65(9.37)	5.58	9.58	15.97	8.17	12.49	17.06	19.78	24.34	29.08
	AICRP-P-39 (V_3)	0.00	0.00	3.02(10.00)	6.15	10.56	16.38	8.83	13.69	18.32	20.24	26.32	31.91
Mean of N_3		0.00	0.00	2.31(8.59)	5.65	9.75	15.93	8.13	12.54	16.87	19.22	24.51	29.46
Mean of Cultivar	K. Pukhraj (V_1)	0.00	0.00	0.63(1.79)	3.41	7.32	12.56	4.92	8.58	10.59	12.97	16.59	20.41
	K. Gaurav (V_2)	0.00	0.00	1.91(3.94)	4.16	8.16	13.58	5.46	9.26	11.84	14.40	18.33	22.64
	AICRP-P-39 (V_3)	0.00	0.00	2.18(4.26)	4.54	8.76	14.27	5.89	10.10	12.88	15.06	20.25	24.22
C.D. at 1% level of significance													
Nitrogen		0.00	0.00	0.12	0.19	0.22	0.28	0.58	1.14	2.06	2.28	3.36	5.08
Cultivar		0.00	0.00	0.08	0.10	0.17	0.15	0.08	0.04	0.10	0.06	0.01	0.02
Nitrogen × Cultivar		0.00	0.00	0.38	0.42	0.34	0.48	1.32	2.46	4.14	4.50	5.17	7.62

(Values in parenthesis are transformed values)

Table 2: Effect of nitrogen doses on sprouting (%) of tubers on weight basis of different potato cultivars during storage under ambient conditions

N doses (kg/ha)	Cultivars	Storage period (days)					
		15	30	45	60	75	90
0 (N_0)	K. Pukhraj (V_1)	0.00	05.25(12.16)	15.62(23.27)	27.88(31.85)	38.23(38.17)	51.39(45.78)
	K. Gaurav (V_2)	0.00	08.86(12.67)	19.45(26.15)	29.66(32.98)	45.82(42.58)	57.84(49.49)
	AICRP-P-39 (V_3)	0.00	10.12(08.54)	18.54(25.49)	28.40(32.19)	42.77(40.82)	56.20(48.54)
Mean of N_0		0.00	8.08(11.12)	17.87(24.97)	28.65(32.34)	42.27(40.52)	55.14(47.94)
80 (N_1)	K. Pukhraj (V_1)	0.00	07.89(15.01)	17.81(24.95)	28.36(32.16)	41.15(39.88)	52.26(46.28)
	K. Gaurav (V_2)	0.00	10.90(17.19)	22.65(28.41)	33.51(35.36)	51.60(45.89)	60.62(51.11)
	AICRP-P-39 (V_3)	0.00	10.36(16.81)	20.76(27.09)	30.34(33.41)	47.63(43.62)	59.63(50.54)
Mean of N_1		0.00	9.72(16.34)	20.41(26.82)	30.74(33.64)	46.79(43.13)	57.51(49.31)
160 (N_2)	K. Pukhraj (V_1)	0.00	09.13(10.37)	21.82(27.83)	32.14(34.52)	49.92(44.93)	60.22(50.88)
	K. Gaurav (V_2)	0.00	11.66(16.31)	24.25(29.49)	34.59(36.01)	56.69(48.82)	63.54(52.84)
	AICRP-P-39 (V_3)	0.00	09.88(14.25)	23.15(28.75)	34.55(35.98)	53.28(46.86)	62.46(52.20)
Mean of N_2		0.00	10.22(13.64)	23.07(28.69)	33.76(35.51)	53.30(46.87)	62.07(51.97)
240 (N_3)	K. Pukhraj (V_1)	0.00	10.22(17.42)	24.53(29.68)	35.21(36.38)	60.98(51.32)	65.12(53.78)
	K. Gaurav (V_2)	0.00	12.56(19.02)	28.50(32.25)	36.42(37.10)	65.23(53.85)	68.90(56.08)
	AICRP-P-39 (V_3)	0.00	12.08(18.02)	26.14(30.73)	36.25(37.00)	62.34(52.12)	66.10(54.38)
Mean of N_3		0.00	11.62(18.15)	26.39(30.89)	35.96(36.83)	62.85(52.43)	66.71(54.75)
Mean of Cultivar	K. Pukhraj (V_1)	0.00	8.12 (11.84)	19.95(26.43)	30.90(33.73)	47.57(43.58)	57.25(49.18)
	K. Gaurav (V_2)	0.00	11.00(16.30)	23.71(29.07)	33.55(35.34)	54.84(47.79)	62.73(52.38)
	AICRP-P-39 (V_3)	0.00	10.61(15.31)	22.15(28.02)	32.39(34.67)	51.51(45.86)	61.10(51.42)
C.D. at 1% level of significance							
Nitrogen		0.00	0.28	0.43	0.61	0.71	0.80
Cultivar		0.00	0.23	0.37	0.52	0.61	0.69
Nitrogen × Cultivar		0.00	0.55	0.75	1.05	1.23	1.38

(Values in parenthesis are transformed values)