Influence of Nitrogen and Bulb Size on the Seed Qualitative Characteristics of Off-Season Onion in Chitwan District, Nepal

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Received on: 5-5-2017, revised on: 28-8-2017, accepted on: 30-8-2017

Abstract

A study was conducted at the farmers' field of Sukranagar, Chitwan to assess the qualitative characters of onion seeds produced by using different nitrogen levels and different sized off season bulbs of var. 'Bemausami-1' (N-8293) during 2009/10. Five levels of nitrogen (0, 40, 80, 120 and 160 kg Nha^{-1}) as main plot factor and three bulb sizes (<1, 1-3 and >3 cm diameter) as sub plot factor were laid out in a split plot design with three replications. Germination (72 %), 1000 seed weight (5.49 gm), viability (88.8%), and vigor index (299.2) were significantly higher at 160 kg Nha^{-1}. Likewise, germination (70.6 %), 1000 seed weight (4.9 gm), viability (86.17), and vigor index (289.5) were higher in the seeds produced from bigger sized bulbs. The lowest germination percentage, 1000 seed weight, viability and seedling length were exhibited by the seeds produced at 0 kg Nha^{-1} and from the bulb sized <1 cm diameter. The qualitative parameters of onion seeds were found to be superior at 160 kg Nha^{-1} and > 3 cm bulb size.

Keywords: *Nitrogen, off season, onion bulb, qualitative characteristics*

Introduction

Onion is an important spice crops among *Allium species.* It ranks third in production among the vegetable crops in the world after tomato and cabbage (FAO, 1996) and second in area under cultivation among the major vegetables and spices after tomato (Pathak, 1994). It is an important vegetable as well as spice crop in Nepal, too. Thapa and Paudyal (2000) reported that it ranked 4th position among the vegetables in terms of its volume and value of the production in Nepal.

Onion is an important vegetable crop prioritized for import substitution in the commercial production programme (VDD, 2009). There was steady demand of 82,996, 387 kg onion bulb worth NRs. 2,196,716,337.00 during 2013/14. It is being increased every year (Nepal Foreign Trade Statistics, 2013/14). Severe scarcity of onion bulbs is seen from August to March in the vegetable markets of Nepal which is fulfilled by import from India in the period (Budhathoki *et al.,* 2004) and the condition is aggravated by the storage losses of up to 88% (Shrivastav and Sharma, 1994).

Vik (1992) and El-Emery (1993) recommended harvesting onion seeds at moisture content between 16 and 53% in order to secure higher germination, viability and vigor. Similarly, the germination rate of seeds gradually and progressively improved with the increase in the level of nitrogen. Seed vigor comprises those properties which determine the potential for rapid uniform emergence and development of normal seedlings under a wide range of field conditions (ASPB, 2003). Seed vigor is generally related to yield in vegetables. In general, when seeds are sown under stressful field conditions, field emergence rather than standard germination is better indication of higher crop yield (Pandey *et al.,*1990).

The performance of most of the seeds deteriorates with prolonged storage, but its rate varies greatly among species (Robert, 1989). Higher temperature, ambient relative humidity and seed moisture content are the main factors influencing seed storage (Abdul-Baki, 1980). The degree of cell membrane damage with ageing can be measured in terms of rate of seed electrolyte leakage (Larson 1968; Simon 1978; Khan *et al.,*2003). Damage to cell membranes with ageing constitute an important factor in explaining seed deterioration (Senaratna *et al.,*1988; Ferguson *et al.,*1990).

The decreased germination, viability and vigor appeared in seeds with ageing might be due to increased membrane destruction (Khan *et al.,* 2004).The highest germination percentage, viability, 100 seed weight, seedling length and vigor index at 150 kg N/ha and 120 kg P/ha was recorded by Ali *et al.,* 2007. Naik and Srinivas (1992) reported that the 1000 seed weight and germination percent increased with the increment in bulb size. Moreover, they found the superior characteristics at 150 kg N/ha. However, the optimum nitrogen requirement for quality onion seeds is inadequately studied in different ecological zones of Nepal.

There is an urgent need of increasing the quantity and quality of onion seed production for import substitution and export promotion. Therefore, the present study aims at identifying the optimum dose of nitrogen and appropriate bulb size for quality onion seed production under Terai condition of Chitwan district of Nepal.

Research Methodology

A two-factor factorial arrangement was laid out in a Split Plot Design. The main factor was nitrogen levels with its five doses (0, 40, 80, 120, and 160 kg/ha) and the subplot factor was three levels of bulb diameter: small (<1 cm), medium (1-3 cm), and large (>3 cm). There were altogether 15 treatment combinations which were replicated thrice. Each replication was divided into main plot at random and subplots were assigned randomly within each main plot. The bulbs were planted at 45×30 cm in every sub plot size (having 4 rows with 5 plants per row) of 2.7 m^2. There were 20 plants per sub plot which were categorized as inner 6 observational plants and other remaining 14 boarder plants. There were altogether 900 plants of which 270 comprised of observational plants. 'Bemausami -1', the popular variety among the farmers of Chitwan, was used. The collected soil samples, following standard procedure, of the research site were tested at Soil Science Laboratory, Department of Horticlture, Hetauda, Makawanpur. The result showed that the soil contained 1.47% organic matter, 0.077% N, 118.2 kg Pha^{-1} and 327.86 kg Kha^{-1}.

Each plot was supplied with well decomposed FYM @ 20 tha^{-1}. Phosphorus and potassium were supplied at the rate of 60 kg/ha each respectively. As per the treatments the nitrogen was applied at different doses (0, 40, 80, 120 and 160 $kgha^{-1}$). Half of the nitrogen and full dose of FYM, phosphorus and potassium were applied as basal dose before transplanting. Remaining half of nitrogen was top-dressed at 50 days after transplantation. Nitrogen was supplied through Urea (46% N) and Diammmonium Phosphate (DAP: 18% N and 46% P) and potash through Murate of potash (60% K). The field was irrigated at 7 days interval and was reduced during seed maturity stage. The onion seeds were harvested by cutting the umbels along with 10-15 cm stalk for easy handling when 10% of the head showed black color. The seeds were threshed and dried up to safe moisture level (12%).

Germination: vigor test*:* From each experimental plot, 100 seeds were taken and put into the moistened cotton cloth separately at the room temperature (around 25^0C) in the horticulture laboratory at Rampur campus. Normal seedlings were first counted after 5 days and final count was done at 10 days. The cumulative value obtained from the first and the second count was expressed as germination %.

$$\text{Germination} = \frac{\text{Normal seedlings}}{\text{Total seeds tested}} \times 100\%$$

The percentage germination was calculated by following the International Seed Testing Association rules (ISTA 1985). The percentage germination was denoted as normal seedling percentage.

Viability test: Viability percentage was calculated during the germination test. All the seedlings, both normal as well as abnormal, were counted and expressed in percentage.

$$\text{Viability \%} = \frac{(\text{Normal seedlings} + \text{abnormal seedlings}) \times 100}{\text{Total seeds tested}}$$

Vigor test: The vigor index was calculated by multiplying percent normal seedling (germination percent) and total seedling length (Shoot length+ Root length) (Abdul-Baki and Anderson, 1973).

Vigor Index = % Germination × (Shoot length + Root length)

1000 seed weight: One thousand sample seeds were randomly counted from the bulk seed of each individual plot of all treatments and were weighed using electronic digital balance. It was recorded in g/1000 seed in all the treatments.

Seedling length (shoot and root length): The seedling shoot and root length were calculated by measuring the randomly selected 5 normal seedlings during germination test (at 10 days) and average of these five seedlings was calculated and expressed in centimeters.

Results and Discussion

1000 seed weight, viability (%), seedling length, germination (%) and vigor index of onion seed: The1000 seed weight of onion at 160 kg Nha^{-1} was significantly the highest (5.49 gm) and the lowest (4.09gm) was at 0 kg Nha^{-1}(Table 1). The result indicates that the seed weight increases with the increase in the level of applied nitrogen. Similarly, bulb size also showed significant effect with the highest 1000 seed weight (4.98 gm) at >3 cm bulb size and the lowest weight (4.37) at <1 cm bulb size (Table 1). The highest viability (88.86%) was found at 160 kg Nha^{-1} and the lowest (79.68%) at 0 kg Nha^{-1}. Bulb size also showed significant effect on viability of seed with 86.17% at >3 cm bulb size and 82.51% at <1 cm bulb size. Seedling length did not differ significantly with the doses of nitrogen and bulb size. However, the highest seedling length (4.15 cm) was obtained at 160 kg Nha^{-1}, whereas the lowest (4.04 cm) at 0 kg Nha-1. With respect to bulb size, the seedling length was the highest (4.12 cm) at 1-3 cm bulb size and the lowest (4.06 cm) at <1 cm bulb size. The germination percentage of onion seed at 160 kg Nha^{-1} was significantly the highest (72.06 %) and the lowest was at 0 kg Nha^{-1} (66.74 %). Similarly, the highest germination percentage (70.64 %) was found at >3 cm bulb size and the lowest at <1 cm bulb size (68.39%). The vigor-index of onion seed at 160 kg Nha^{-1} (299.2) was significantly the highest (299.2) and the lowest was at 0 kg Nha^{-1} (269.9). Similarly, the highest vigor-index (289.5) was found at >3 cm bulb size and the lowest at <1 cm bulb size (277.6). The interaction effect of nitrogen and bulb size on 1000 seed weight, viability (%), seedling length, germination (%) and vigor index was found to be non significant. The higher viability might be due to higher 1000 seed weight. Ali *et al.,* 2007 found the highest seed weight (5.5 gm/1000 seed) from 150 kg Nha^{-1} whereas the lowest seed weight (2.72 gm/1000 seed) was obtained from control treatment (0 kg Nha^{-1}). Also, the 1000-seed weight significantly increased with the increase in bulb size from 4 to 6 cm. Several other authors (Singh and Sachan 1998; Ali *et al.,* 1998) have also reported similar results.

Table 1. 1000 seed weight, viability, seedling length, germination % and vigor index of onion seed at different doses of nitrogen and bulb size at Sukranagar, Chitwan, Nepal, 2009/10

Treatments	1000 seed weight (gm)	Viability (%)	Seedling length (cm)	Germination (%)	Vigor-index
Nitrogen (Main factor)					
N_1 (0 kg N/ha)	4.09 ^{b}	79.68 ^{c}	4.04^{ab}	66.74 ^{c}	269.9 ^{e}
N_2 (40 kg N/ha)	4.33 ^{b}	82.20^{bc}	4.00 ^{b}	68.92 ^{b}	275.5 ^{d}
N_3 (80 kg N/ha)	4.51 ^{b}	85.16^{ab}	4.12 ^{a}	68.86 ^{b}	283.6 ^{c}
N_4 (120 kg N/ha)	4.88^{ab}	85.91^{ab}	4.14 ^{a}	70.26 ^{b}	291.2 ^{b}
N_5 (160 kg N/ha)	5.49 ^{a}	88.86^{a}	4.15 ^{a}	72.06 ^{a}	299.2 ^{a}
S E_m	0.25	1.40	0.03	0.50	1.03
LSD	0.82	4.57	NS	1.66	3.36
CV%	3.11	2.73	2.46	2.36	1.18
Bulb size (Sub factor)					
B_1 (<1 cm)	4.37 ^{c}	82.51 ^{c}	4.06 ^{a}	68.39 ^{b}	277.6 ^{c}
B_2 (1-3 cm)	4.63 ^{b}	84.40 ^{b}	4.12 ^{a}	69.07 ^{b}	284.6 ^{b}
B_3 (>3 cm)	4.98 ^{a}	86.17 ^{a}	4.10 ^{a}	70.64 ^{a}	289.5 ^{a}
S E_m	0.03	0.59	0.02	0.42	0.86
LSD	0.11	1.75	NS	1.24	2.55
CV%	3.11	2.73	2.46	2.36	1.18

N_1, N_2, N_3, N_4 and N_5 represent 0, 40, 80, 120 and 160 kg Nha^{-1} respectively and B_1, B_2 and B3 represent <1 cm, 1-3 cm and >3 cm bulb size respectively. Treatment means followed by common letter (s) are not significantly different from each other based on DMRT at 5% level of significance.

Higher the 1000 seed weight, the more would be the reserved food material in the seed. Nitrogen had a greater effect on germination rate of seed. The percentage of germination of seed gradually increased with the increase in the level of nitrogen up to 150 $kgha^{-1}$. Further increase in the level of nitrogen had no effect but identical (Ali *et al.,* 2008; Asadussaman *et al.,* 2012; Naik and Srinivas, 1992 and Singh and Sachhan,1998).

The highest vigor index at 160 kg Nha^{-1} as well as at > 3 cm bulb size might have been due to more germination percent, higher seedling length and higher 1000 seed weight at 160 kg $Nha^{-1}$and bulb size of >3 cm diameter.

Conclusion

The qualitative parameters viz. 1000 seed weight, viability (%), seedling length, germination (%) and vigor index were found to be significantly superior in the seeds produced with the application of higher dose of nitrogen i.e. 160 $kgha^{-1}$ and planting of larger sized bulb i.e. > 3 cm diameter in the plain areas of Chitwan. Thus, the study suggests to use 160 kg Nha^{-1} and > 3 cm bulb size as planting material for obtaining onion seed of better quality under such condition. This study also suggests that further researches need to be conducted still at higher doses of nitrogen using various sized bulbs under different agro-climatic conditions to assess the production of onion seed.

Acknowledgement

We would like to express our sincere thanks to National Agriculture Research Development Fund for providing financial support and Directorate of Research of the Institute of Agriculture and Animal Sciences, Rampur, Chitwan, Nepal for timely providing necessary facilities and logistic supports.

References

Abdul-Baki, A.A. 1980. Biochemical aspects of seed vigor. Journal of Horticulture Science 15: 765-771.

Abdul-Baki, A.A. and J.D. Anderson. 1973. Vigor determination in soyabean seed by multiple criteria. Journal of Crop Science 13: 630-663.

Ali, M.K., M.F. Alam, M.N. Alam, M.S. Islam and S.M.A.T. Khandaker. 2007. Effect of nitrogen and potassium level on yield and quality seed production of onion.Research Journal of Applied Science 3(12): 1889-1899.

Ali, M.K., M.N. Alam, M.S. Islam, M.K. Islam and M.A. Baree. 2008. Effect of cowdung at different level of phosphorus on growth, yield and quality seed production of onion. Research Journal of Agricultural Science 4(1): 86-93.

Haile, A., B. Tesafaye and W. Worku. 2017, Seed yield of onion (*Allium cepa*L.) as affected by bulbsize and intrarow spacing. African Journal of Agriculture Research 12 (12): 987-96.

AsaduzzamanM.D.,M. Hasan, M. Hasan and M. Moniruzzaman. 2012..Quality seed production of onion (*Allium cepa* L.): An integrated approach ofbulb sizeand plant spacing. BangladeshJournal of Agriculture Research 50(1):119-128.

Ali, N., A.M. Baloch and A.S. Hussain. 1998. Study the effects of planting space and bulb size on seed production. Sarhad Journal of Agriculture 14: 563-568.

ASPB. 2003. Regulations on the sale of planting seed. Page 72203. Arkansas State Plant Board, Box 1069, Little Rock, Arkansas, America.

Budhathoki, K., H.N. Regmi, N.G. Pradhan, P.R. Bhurtyal and D.R. Bhattarai. 2004. Effect of set planting date on off season on onion bulb production in mid hills. Pages 419-421 in Advances of Horticultural Proceeding in Nepal. Nepal Agricultural Research Council, National Agricultural Research Institute and Horticultural Research Division, Khumaltar, Lalitpur.

El-Emery, M.I. 1993. Effect of maturity stage at harvesting on seed viability and seedling vigourof onion. Annual Agriculture Science 38 (1): 203-217.

FAO. 1996. Selected indicators of food and agriculture development in Asia Pacific Region:Report submitted to Regional Office for Asia and the Pacific (RAP), FAO, UN, Bangkok. Pages 412-414.

Ferguson, J.M., D.M. Tekrony and D.E. Egli. 1990. Changes during early seed and axes deterioration. Crop Science 30: 179-182.

ISTA. 1985. International rules for seed testing. Seed Science Technology 13: 299-335.

Khan, M. M., M. J. Iqbal, M. Abbas, H. Raza, R. Waseem and A. Ali. 2004. Loss of vigour and viability in aged onion (Allium cepa L.) seeds. Accelerated ageing studies on onion seed. International Journal of Agricultural and Biological Science6: 198-211.

Khan, M.M., M.J. Iqbal, M. Abbas and M. Usman. 2003. Effect of accelerated ageing on viability, vigor and chromosomal damage in pea (*Pisumsativum* L.) seeds. Pakistan Journal of Agricultural Science 40: 50-54.

Larson, L.A. 1968. The effect of soaking pea seeds with or without seed coats on seedling growth. Plant Physiology 43: 255-259.

MOP, 2008. Annual Progress Report (2064/65: Mission Onion Program:Report submitted to Vegetable Development Division, Khumaltar, Lalitpur, Nepal. Page 80.

Naik, L.B. and K. Sirnivas. 1992. Seed production of vegetable crops.A review. Agriculture Review 13(2): 59-80.

Nepal Foreign Trade Statistics. 2013/14. Vegetable import statistics. Trade and Export Promotion Center, Pulchowk, Lalitpur, Nepal.

Pandey, P.K., R.D. Goyal, V. Parakash, R.P. Katiyar and C.B. Singh. 1990. Association between laboratory vigor tests and field emergence in cucurbits. Seed Research 18: 40-43.

Pathak, C.P. 1994. Allium improvement for the tropics: Problems and AVRDC Strategy. Pages 421-425 in D. J. Midmore (editor). International Symposium on Alliums for the Tropics, Bangkok, Chiangmai, Thailand 15-19 February 1993. Asian Regional Center AVRDC.

Robert, E.H. 1989. Seed storage for genetic conservation. American Journal ofEnvironmental Science2: 12-18.

Senaratna, T., J.F. Gusse and B.D. McKersie. 1988. Age induced changes in cellular membranes of imbibed soybean seed axes. Plant Physiology 73: 85-90.

Shrivastava, A. and M.D. Sharma. 1994. Suitability of locally available containers for the storage of onion bulb:Report submitted to Institute of Agriculture and Animal Science, Rampur, Chitwan, Nepal. Page 73-75.

Simon, E.W. 1978. Membranes in dry and imbibing seeds. Pages 205-224 in J.H. Crowe, J.S. Clegg (editors).Dry Biological Systems,Academic Press, New York, USA.

Singh, S.R. and B.P. Sachan. 1998. Response of different bulb sizes and varieties on onion (*Allium cepa* L.). Hisar Crop Research 15: 57-60.

Thapa, G.B. and D. Paudyal. 2000. Nepal. Pages 231-270 in M. Ali (editor). Dynamics of Vegetable Production, Distribution and Consumption in Asia, Kalyani Publishers, India.

VDD, 2009. Annual Progress Report(2065/66): Vegetable Development Division:Report submitted to Ministry of Agriculture and Cooperatives, Singha Durbar, Kathmandu. Pages110.

Vik, J. 1992. Influence of harvest time and method on seed yield and quality in onion. Norwegian Journal of Agricultural Science6: 463-468.