

EFFECT OF BULB SIZE AND SPACING ON QUALITY SEED PRODUCTION OF ONION (*ALLIUM CEPA* L.) : A REVIEW

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ABSTRACT

Mother bulb size exerts significant influence on quality onion seed production. Lack of knowledge of onion seed growers in India regarding bulb size is responsible for poor seed yield and low quality onion seed. The larger the mother bulb, higher the seed yield per plant. Plant and row spacing are important factor for maintaining the optimum plant population to produce optimum yield with excellent seed quality. Due to the lack of adequate knowledge on different aspects of seed production, particularly the adequate size of mother bulbs and optimum spacing, the growers are reluctant to seed production. Therefore, the effect of bulb size and plant spacing on quality seed production of onion is being reviewed herewith may helpful to the researchers in planning and execution of future research.

KEY WORDS: *Bulb size, onion, quality, seed production, spacing*

INTRODUCTION

Every year the area under onion cultivation in India is increasing, but the farmers are facing the shortage of high quality seeds. Seed production is a vital part in onion growing and is a highly specialized business requiring particular knowledge and training. Generally, onion seed is produced from planting mother bulbs. Onion seed price is directly proportional to onion bulb price used for growing seed crop (Mondal and Choudhury, 1980). Bulb-to-seed method is appropriate for onion seed production (Rahim *et al.*, 1982).

Onion is a biennial crop for the purpose of seed production. In one season, bulbs are produced from seed and in the second season, bulbs are replanted to

produce seeds. Demand of onion seed is increasing due to increase in onion consumption. To sustain onion production, it is very difficult to increase yield horizontally, but there exists a great scope to do the same vertically that could be achieved by using good quality seed.

Bulb size and plant spacing are considered important factors reflected in seed parameters of onion seed. Bulb size and plant spacing are the key factors in producing good quality onion seeds (Mirshekari and Mobasher, 2006). Considering that an increase in size of bulb results in higher seed yield but large size bulbs if used will need a very high seed rate (Khokhar, 2009). Singh *et al.* (1990) found that the highest planting density (30 cm × 30 cm) gave a significantly higher seed

yield per unit area compared to other spacing, but the lowest seed yields per umbel and per plant and 1000 seed weight. Levy *et al.* (1981) found that under arid conditions, large mother bulbs and high plant density (60 cm x 10 cm) gave the best results.

Effect of bulb size on quality seed production of onion

As early as 1939, Jones and Emsweller reported that increase in size of bulb was accompanied by an increase in number of seed heads per plant, seed yield per plot and seed yield per acre. Arkeri and Patil (1956) found that planting bulbs larger than three inches in diameter produced more seeds per plant and per acre. Solomon and Patil (1959) exposed that large mother bulbs produced more seed heads, more seeds per plant and higher seed weight per plant than smaller bulbs. The larger bulbs also came into bloom earlier and they recommended plantings bulbs not less than 40 g in weight for onion seed production. In Egypt, Attia *et al.* (1960) tested that large onion produced 38 per cent and the medium onion produced 27 per cent more seeds per plant than the small bulbs.

Jyotishi and Pandey (1970) examined that, the medium sized bulb having 2.54 to 3.80 cm diameter were the best for production of the seed and was also economical. Seed bulbs obtained from small sets formed more scapes per bulb and gave a greater seed yield than seed bulbs formed from medium and large sets (Cherepova and Yakubovskaya, 1972). They also reported that set size had no effect on seed quality. Prokhorov and Khomakar (1972) reported that, the bigger sized bulbs flowered earlier, and earlier the plant flowered, the higher was the number of seeds with better quality. Orlovskii (1974) observed that bulbs of 4 to 7 cm diameter were the best for optimum economic results although the seed yield was increased with increase in the size of the

mother bulbs. Egorov *et al.* (1975) obtained higher seed yield from large bulb size greater than 60 mm (8.58 q/ha). Velichko and Lukomets (1976) reported that seed yield was increased with bulb size from small (30 g) to medium (70 g) to large (110 g). Rusev (1978b) found after trials with three onion cultivars that with the increase in bulb size, seed yield per unit area increased.

Mondal and Choudhury (1980) reported that seed head and seed yield were increased with the increase in bulb size. Tudzarov (1982) showed that the most suitable weight was 60-120 g (including fraction of 2 and 3), giving the best developed and most uniformly ripening seed plants, while large bulbs produced less productive flowering stalks. Singh *et al.* (1983) observed that, the seed yield was highest (8.24 q/ha) from large bulbs and declined to 7.89 and 5.91 q/ha for medium and small bulbs, respectively. Mishra (1986) reported that the highest mean seed yield was found from the largest bulbs with better germination percentage. Nehra *et al.* (1988) reported that large size bulbs of 50 g and above significantly increased the plant height, number of sprouts and scapes and seed yield in comparison to small and medium size bulbs. Ali *et al.* (1989) tested three size large, medium and small and reported that the larger mother bulbs produced more number of umbels per plant and higher seed yield per plant. Toman *et al.* (1989) reported 27, 47 and 62 per cent higher seed yield with graded mother bulb having diameter of 50.1 to 60.0 mm, 60.1 to 70.0 mm and 70.1 to 80.0 mm, respectively, over ungraded bulbs.

The maximum number of scapes per plant and seed yield per hectare was due to large size bulbs were reported by Singh (1991). Vik (1992) reported that the seed yield increased by 31 per cent from the smallest to the largest size of mother bulbs.

A study on cultural and nutritional aspects of seed production of onion showed that large size bulbs of 50 g and above significantly increased the number of scapes per plant, seed yield per plant and per hectare in comparison to small and medium size bulbs (Nehra *et al.*, 1994). Verma *et al.* (1994) reported that number of days to 100 per cent sprouting, number of branches per plant, average branch length, number of seed stalks per plant, total seed yield per plot and average seed yield per plant were increased linearly with the rise in bulb size of onion. Alam (1995) obtained the highest seed yield of onion per plant and per hectare from large bulbs (9.5 ± 1 g) and it was declined as the bulb size was reduced.

Faraq and Koriem (1996) observed that, per cent emergence, number of heads per plant, length of seed stalks and seed yield increased significantly with the increase in bulb size from 3.5 to 4.5 cm to 6.8 cm. Gamie *et al.* (1996) found that number of seed stalks per plant and seed yield per umbel and per plant was significantly and positively correlated with bulb size. Oladiran and Ifere (1996) found that non-significant effect of bulb size on number of inflorescence per bulb, inflorescence height and 1000 seed weight. Singh and Sachan (1999a) reported that, the large bulb produced taller plants, and a higher number of leaves per plant, number of umbels per plant, 1000 seed weight and seed yield per hectare for both the cultivars.

Shaikh *et al.* (2002) reported that large size bulbs gave significantly the higher plant height, number of leaves per plant, umbels per plant, umbel diameter, seed weight per umbel, seed yield per plant and per hectare, seed germination and seedling vigour over other sizes. Singh (2003) observed that large size bulbs gave the better results with respect to plant height, days to 50 percent bolting, number of leaves per plant, numbers of umbels per plant, seed

weight per plant, seed yield per plot, seed yield per hectare and 1000 seed weight. Singh *et al.* (2005) obtained the maximum seed yield in bulb diameter (6.0 x 4.5 cm).

The vegetative growth as well as seed production ability of the plants increased gradually with the increase in bulb size. The highest seed yield, highest per cent of seed germination was obtained from the variety large sized bulbs by Faruki (2006). Geetharani and Ponnuswamy (2007) reported that larger sized bulbs and allowing three umbels per plant was more suitable for production of highly valuable breeder and nucleus seeds. Sharma *et al.* (2008) from two year's results reported that planting of large size bulbs significantly increased the seed yield over medium size of bulbs. Ashrafuzzaman *et al.* (2009) reported that plant height, number of leaves per plant, length of scape, effective fruits per umbel, percentage of fruit set and seed yield were positively influenced by bulb size of onion. Morozowska and Hołubowicz (2009) discovered that bulb size had no effect on the seed stalk height, seed yield per one seed stalk and weight of 1000 seeds but it did affect the seed yield obtained from the entire plant, which was bigger for plants grown from large bulbs in comparison with the small ones. Badawi *et al.* (2010) observed significant differences among the three studied size of mother bulbs in seed quality characters *i.e.* germination percentage, speed of germination, shoot and root length and seedling dry weight in both seasons. Dudhat *et al.* (2010) produced the highest seed yield by the planting of large size of onion bulb (7 to 8 cm) with highest net return. The highest benefit cost ratio of was recorded by the planting medium bulb size of 5 to 6 cm.

Khodadadi (2012) found that the mother bulb size factor had significant effect on all traits except for plant height. The highest seed yield belongs mother bulb size 65 to 80 mm. Jagtap *et al.* (2014)

concluded that large bulb size having diameter 65 mm and above when planted on 9th November were most efficient in growth, maximum flowering and higher quality seed yield of onion. Teshome *et al.* (2014) found that large bulbs increased germination percentage by 13.32 per cent than the small bulbs. The highest seed yield was obtained from large sized mother bulb. Ali *et al.* (2015) reported that the big bulbs (12 g) gave larger numbers of umbels per plant, seed yield obtained from the entire plant. The bulb size also did not affect seed yield per one seed stalk. Debashis *et al.* (2016) concluded that planting of large size bulb produced significantly better results in all the characteristics under the study than other medium and small size bulb. From economic point of view, the combination of large mother bulb planted on 15th November was most suitable for quality seed production of onion.

Effect of bulb spacing on quality seed production of onion

During the studies on spacing of onion bulbs, Jones and Emsweller (1939) found that close spacing of onion bulbs increased the seed yield per unit area. It was further observed that increase in spacing between plants resulted in increased the number of seed stalks, but were not sufficient to compensate the yield. Experiment by Patil (1960) revealed that higher seed yield was obtained from the narrower spacing (12 inch x 6 inch, rows and bulbs, respectively). Seed stalks per plant increased with increased in spacing. Decampos *et al.* (1968) investigated the effects of bulb spacing on onion seed production and obtained higher seed yield per plant with wider spacing, but higher seed yield per hectare was obtained at closer spacing. Results of experiments carried out for two successive seasons by Abdalla (1969) revealed that yield per plant increased with increase in spacing, but

closer spacing gave the highest yield per unit area. Jyotishi and Pandey (1970) reported that for getting the maximum yield of seed, the onion bulbs should be planted at a distance of 45-60 cm, between row and 30 cm between the plants.

Machala and Mazella (1971) conducted an experiment to find out the effect of spacing and fertilization on the quality and quantity of onion seed and reported that when onion plants were given a growing area of 1000 to 1300 square cm (50-65 cm x 20 cm), it produced maximum seed yield. Orlovskii (1973) concluded that there was no effect of the various spacing on seed quality though they affected the seed yield. The optimum spacing recommended for seed crop was 50 cm x 20 cm and 60 cm x 20 cm. Arsagova and Zakaidze (1974) planted bulbs at 15, 25 and 35 cm apart within rows, the rows being 70 cm apart and observed that the highest yield of onion seed with top quality was obtained from bulbs planted at 70 cm x 15 cm apart. Singh *et al.* (1974) recorded the highest seed yield under closest spacing of 10 cm x 30 cm. The yield of seed per plant considerably improved as the plant population per plot reduced due to increased in spacing between bulbs at planting. Rashid and Rashid (1976) obtained the highest seed yield of onion at wider plant spacing (20 cm x 10 cm in a single row system and 10 cm x 10 cm in a multiple row system). Singh and Rathore (1977) harvested the highest seed yield per plant from the widest spacing. On the contrary, yield per hectare was noted the highest at the least spacing. Rusev (1978a) reported that the yield increased with decreasing growing space and were the highest with the growing space of 420 cm² (70 cm x 6 cm) as compared with 1050 cm² (70 cm x 15 cm) and 1750 cm² (70 cm x 25 cm).

Levy *et al.* (1981) obtained the highest seed yield per hectare at higher plant densities as compared to lower plant

densities. Lal *et al.* (1982) reported that, plants spaced at 75 cm x 20 cm, 75 cm x 25 cm and 75 cm x 30 cm gave a seed yield of 2.1, 1.85 and 1.75 q/ha, respectively, which showed that the closer spacing (75 cm x 20 cm) gave the highest yield. Nourai (1984) found that two rows per raised bed 20 or 35 cm apart within row spacing of 15 or 25 cm gave better yields than lower densities. Singh and Singh (1984) planted the bulbs of Patna Red at 30 cm x 10 cm, 30 cm x 20 cm, 30 cm x 30 cm and 30 cm x 40 cm. They discovered planting of the bulbs at 30 cm x 10 cm spacing gave the highest seed yield.

Arguelles *et al.* (1986) recorded the highest seed yield at the closest spacing. Steiner (1986) spaced the bulbs at 12, 24, 48 and 72 cm apart in single rows on 1 m beds and found that when bulb spacing was greater than 12 cm, produced plants which exhibited between 15 and 18 per cent loading of scapes. This was attributed to a wider horizontal display of the umbels within the canopy and the time at which the umbels emerged from the capsule sheath was delayed as bulb spacing decreased. Increasing plant spacing resulted in greater number of scapes per unit area which increased the final seed yield. There was no effect of plant population on seed quality. Nehra *et al.* (1988) found that the number of scapes and seed yield per plant were higher under wider spacing, however, seed yield per hectare was significantly higher under closer spacing. Plant spacing had no influence on phonological characters like flower initiation, completion of 50 per cent flowering and maturity. Singh *et al.* (1988) reported that the highest seed yield was obtained from plants spaced at 45 x 30 cm. It was also found that wider spacing (60 cm x 45 cm) increased plant height and number of leaves as compared to narrow spacing (45 cm x 30 cm). The highest number of flowering scape was reported under wider spacing. Bhonde *et al.* (1989) noted that the

highest seed yield under 45 cm x 30 cm spacing with 80 kg N/ha. The highest plant density (30 cm x 30 cm) gave significantly higher seed yield per unit area compared to the other spacing, but seed yield per umbel and per plant were the lowest in the closest spacing (30 cm x 30 cm) observed by Singh *et al.* (1990).

Bhardwaj (1991) found that, the highest planting density (30 cm x 30 cm) gave significantly the highest seed yield per unit area compared to the other spacing. The topmost seed yield per plot (641.60 g) was obtained in 30 cm x 30 cm. Pandey *et al.* (1992) found that the closest spacing (45 cm x 30 cm) gave the highest seed yield compared to other spacing 60 cm x 30 cm and 60 cm x 45 cm on economic point of view. The growth characters, plant height, number of leaves per plant, total number of umbels per plant and size of umbel increased under medium row spacing (30 cm x 30 cm). The bulb planted at medium row spacing (30 cm x 30 cm) increase the seed production of *kharif* onion these suggested by Singh *et al.* (1994). Gaikwad (1996) reported that higher yield per plot and yield per hectare resulted from closer spacing 60 cm x 20 cm, but Spacing did not show any significant effect on seed germination percentage, physical purity percentage, colour of seed and concentration of K in leaves. Begum *et al.* (1998) recorded the highest number of seeds per umbel from the crop planted at wider spacing (30 cm x 20 cm). Kanwar *et al.* (2000) planted the bulbs at the spacing of 45 cm x 30 cm, 60 cm x 30 cm and 60 cm x 60 cm and recorded the highest yield per hectare at the closest spacing of 45 cm x 30 cm, but the increasing in the seed yield per unit area is up to certain limit.

Tiwari *et al.* (2002) found that crop planted at 60 cm x 45 cm spacing produced the highest number of leaves per plant and test weight, whereas the crop planted at 45

cm x 30 cm spacing produced the highest length of flower stalk and seed yield per hectare. Mahadeen (2004) reported that onion crop planted at wider spacing (60 cm x 45 cm) resulted in highest seed yield per plant, seed germination percentage, test weight, seed vigour index-I and seed vigour index-II, while the crop planted at closer spacing (60 cm x 15 cm) resulted in highest seed yield per hectare. Pandita *et al.* (2004) found that closer planting (40 cm x 10 cm) produced maximum scape height compared to wider spacing. While, Umbels per plant, seed with higher 1000 seed weight, germination and vigour was more in wider spacing 50 cm x 50 cm but, the maximum processed seed yield was recorded at an optimum plant spacing of 40 cm x 30 cm. Singh and Ahmed (2005) reported that plant spacing of 30 cm x 10 cm resulted in maximum plant height, while the crop planted at 30 cm x 20 cm plant spacing resulted in maximum number of sprouts per hill, number of umbellate, number of seeds per umbel, seed yield and seed germination percentage. Aminpour *et al.* (2006) found that the number of capsules per umbel increased in 15 cm plant space as compared to the other planting spaces. Among yield components, umbels per m² and capsules per umbel had the most contribution in the seed yield variation, but on the seed quality traits no effect of spacing. Dudhat *et al.* (2010) recorded the highest seed yield by the planting of bulbs at 30 cm x 30 cm spacing with maximum net returns and the highest benefit cost ratio.

Barman *et al.* (2013) found that planting of bulbs at a closer spacing of 45 cm x 15 cm resulted with maximum plant height at 90 and 120 DAP over other spacing levels. While, onion bulbs planted at a closer spacing of 45 cm x 15 cm gave maximum number of leaves on 90 DAP and took least number of days for 50 per cent scape emergence and 50 per cent flowering.

Elhag and Osman (2013) planted bulb on both sides of 70 cm ridges at 2.5, 5, 10 and 12.5 cm within ridge spacing. After harvest they tested seed directly for germination (germination percentage, rate and uniformity) in petri dishes and emergence (emergence percentage, rate and uniformity) in soil in plastic seeds were again tested for germination after one and two years storage in paper bags at room temperature. The results showed that the widest spacing had positive effects on germination, emergence percentage and rate of germination. The closest spacing reduce ageing rate during storage under normal storage conditions. They recommended medium within row spacing (10 cm) for high onion seed yield and quality. Elhag and Osman (2014) recorded the minimum number of days to 50 per cent flowering, maximum number of leaves per plant, number of umbels per plant, number of seeds per umbel and seed yield per plant in crop planted at wider spacing. Whereas, crop planted at closer spacing resulted in maximum plant height and seed yield per hectare. Kumar *et al.* (2015) observed that the all plant and seed parameters in plant planted at 60 cm x 30 cm (S₃) as well as the incidence of disease, disease severity index and scape lodging (%) were significantly also lower. Teshome *et al.* (2015) revealed that the highest seed yield was obtained in response to planting fungicide treated topped bulbs at the both double-row spacing. However, significantly higher values of all seed quality parameters were obtained from both single-row spacing. The bulb planted at narrow spacing (15 cm) recorded the highest leaves length. But the bulb spacing of 25 cm resulted in the biggest number of flowers per umbel and the longest flowering stalk were concluded by El Abas *et al.* (2016).

Interaction effect of bulb size and spacing on quality seed production of onion

Pall and Padda (1972) found that the number of days taken from planting to the completion of 50 per cent flowering was hastened by the use of big bulbs. The seed yield per hectare increased with close plant spacing of 20 cm and with the use of big size bulbs of 50 g. Arsagova and Zakaidze (1974) noted the highest yield of top quality from large mother bulbs, i.e., 50-55 cm planted at 70 cm x 15 cm as compared to 30-35 mm diameter bulbs. Chang (1979) concluded that the highest seed yield in onion could be obtained by raising the plants from bulbs of 6.6-10.0 cm diameter and space planted at 80 cm x 20 or 80 cm x 30 cm. Rathore *et al.* (1980) reported that the size of mother bulb had a remarkable effect on the performance of a seed crop. The flowering stalk per plant and yield of onion seed were directly related with the size of mother bulbs used for planting.

Madan and Saimbhi (1984) planted large (5 cm diameter) and medium (3 cm diameter) sized bulbs of cv. Punjab48 at a distance of 30 or 45 cm between rows and reported that bulb size and row spacing had little effect on mean seed yield. The maximum number of scapes per plant and seed yield per hectare was produced by large bulbs when planted at closest spacing of 30 cm x 30 cm, whereas seed yield per plant was obtained the highest with large bulbs planted in wider spacing 45 cm x 45 cm reported by Lal *et al.* (1987). Bhardwaj (1991) obtained the highest seed yield per plot from large bulbs planted at 30 cm x 30 cm. Singh (1991) found that the maximum number of scapes per plant and seed yield per hectare was produced by large size bulbs when planted at closer spacing of 30 cm x 30 cm. Nehra *et al.* (1994) observed that the interaction of bulb size and plant spacing was significant and highest seed yield was recorded with bulb of size 50 g and above planted at 30 cm apart. Sarnaik *et al.* (1995) obtained the highest yield of seed with

closest spacing (15 cm x 15 cm). However, the net profit was obtained the highest at 45 x 45 cm spacing followed by 45 cm x 30 cm spacing which returned as net profit from one hectare. The lowest net profit at the closest spacing was attributed to the high cost of planting material.

Chaturvedi (1996) obtained the maximum seed yield per unit area in large sized bulbs planted at closest spacing (45 cm x 15 cm). With due consideration of economics of seed production, large sized bulbs (60 to 90 g) planted at 45 cm x 30 cm or medium sized bulbs (30 to 60 g) planted at 60 cm x 15 cm is the best for onion seed production. Ali *et al.* (1998) recorded the early flowering, early seed maturity and per hectare yield in 10 cm plant spacing. Yield per plant and 1000 seeds weight were significantly higher in plants spaced at 30 cm was maximum in plants spaced at 10 cm. Larger bulb size (5.5 - 7.0 cm) significantly enhanced seed yield per plant, 1000 seed weight and seed yield per hectare. Dadhania and Gajipara (1998) recorded the highest seed yield per plant in bulb size 3.6-4.5 cm, spacing 60 cm x 30 cm combination. The highest seed yield of onion per hectare (21.85 g) was found in treatment combination 3.6-4.5 cm size of bulb and spacing of 30 cm x 30 cm. Singh and Sachan (1998) reported that the wider spacing and larger bulb size were important for more plant height, number of leaves, number of scapes and higher seed yield per plant. Singh and Sachan (1999b) recorded the highest number of scapes per plant and seed yield per plant from treatment combination of wider spacing (30 cm x 45 cm) and large bulb size (4.0 to 5.0 cm). They further reported that the closest spacing and the largest bulb size gave the highest seed yield/ha.

Yadav *et al.* (2002) found that larger bulbs (5.5 to 6.5 cm) planted at the spacing of 45 cm x 30 cm resulted in high number of

umbels per plant and seed yield/ha. Aminpour and Mortazavibak (2004) reported that the plants under 50 cm spacing and 6.5-9.5 cm bulb size gave the highest seed yield and umbels per m². Plant density and bulb size had insignificant effect on seed germination. Mahadeen (2004) concluded that the higher plant density 60 cm x 45 cm and large mother bulbs (7.1-9.0 cm) produced more seed yield per ha. While, planting medium size bulbs (5.1-7.0 cm) at medium 60 cm x 30 cm or low plant density 60 cm x 15 cm are more practical and preferred for seed production. Singh and Ahmed (2005) observed the maximum average seed yields (10.50 to 11.20 q/ha) in medium sized bulbs were planted at 30 cm x 20 cm. Seed germination was unaffected by the treatments. Sowing of bulbs larger than 6.5 cm diameter and density of 14.3 plants / m² planted on 20 March was the best treatment combination for getting higher seed yields reported by Mirshekari and Mobasher (2006). Singh *et al.* (2007) observed the maximum seed yield with superior growth characters with 5.0–6.0cm bulb size and 30 cm x 30cm spacing. Mirshekari *et al.* (2008) found that seed bulbs of 6.5 cm or bigger in diameter on 20 March with plant spacing of 35 cm x 20 cm is gave highest seed yield, 1000seed weight, stem lodging percentage, umbrella diameter, seed yield of single plant and stem height.

Asaduzzaman *et al.* (2012a) obtained the highest seed yield per hectare from the large bulb (15 ± 2g) with the closest spacing of 25 cm x 15 cm. Hence, large bulb size (15 ± 2g) with closest plant spacing (25 cm x 15 cm) is suggested for onion seed production in northern part of Bangladesh. Asaduzzaman *et al.* (2012b) obtained the highest seed yield per plant (3.78 g) from large bulb (20 ± 1g) at closer spacing of 25 cm x 20 cm, whereas maximum seed yield per plot was obtained with large bulb size (20 ± 1g) with minimum spacing of 25 cm x

10 cm. The highest seed germination percentage was obtained from same bulb size with spacing of 25 cm x 15 cm. Asaduzzaman *et al.* (2015) reported that the maximum umbel diameter, number of flowers per umbel, number of seeded fruits per umbel, seed yield per plant and the highest seed germination were with 100 plants per 6 m² and the highest seed yield per plot was obtained at 200 plants per 6 m² when heaviest bulbs were used. For quality onion seed production, a heavy bulb established at the lowest plant density provided the best results. El-Damarany *et al.* (2015) recorded the maximum seed yield per feddan with the large bulb size and the medium planting space (40 cm).

Haile *et al.* (2017) concluded that the interaction effects of bulb size and intra-row spacing on number of seeds per umbel, weight of seeds per umbel, seed yield per plant and seed yield per hectare were significant. Significantly higher seed yield was obtained at the larger bulb size (5.1 to 7 cm) grown at 20 and 25 cm spacing. The highest net field benefit was obtained from a bulb of 5.1-6.0 cm sizes grown at 20 cm spacing. Ginoya *et al.* (2018a) reported that large size onion bulbs of onion should be planted at the spacing of 45 cm x 30-40 cm for getting higher seed yield. Ginoya *et al.* (2018b) suggested that for getting the higher onion seed yield and net return, large size onion bulbs of onion should be planted at the spacing of 45 cm x 30-40 cm.

CONCLUSION

For getting the higher onion seed yield and net return, large size onion bulbs should be planted at the spacing of 45 cm x 30-40 cm.

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