Influence of Mother Bulb Weight and Spacing on Quality Seed Yield of Onion

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Influence of Mother Bulb Weight and Spacing on Quality Seed Yield of Onion

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Abstract: The present study was conducted to investigate the effect of mother bulb weight and spacing on onion seed production under Red and Laterite Zone of West Bengal, India. The mother bulbs were produced from botanical seed, were graded and stored under ambient condition up to November 2016. In *Rabi* 2016-2017, three levels of spacing [S1 (22.5 cm × 30 cm), S2 (30 cm × 30 cm) and S3 (45 cm × 30 cm)] and three levels of mother bulb weight [B1 (30-50g), B2 (51-65g) and B3 (66-80g)] were assessed. Maximum leaves per plant, umbel diameter, flowers per umbel and seeds per umbel was observed in wider spacing and also when larger bulbs were planted. The planting of bigger sized bulbs produced maximum number of scape per plant. Maximum seed yield (857.80 kg/ha) was obtained by following 30cm x 30cm spacing, which was similar to closely spaced plants of 22.5 cm × 30 cm. High seed yield (923.35 kg/ha) of good quality was also recorded by planting large sized bulbs (66-80g), which was superior than planting of medium and small sized bulbs. The combination of planting medium size bulbs (51-65g) in 30cm x 30cm spacing resulted in high seed yield. However, planting of large sized bulbs (66-80g) following any spacing ensures high seed yield with high seed germination.

***Keywords*:** *Allium cepa*, Bulb size, Spacing, Growth, Seed yield

Onion (*Allium cepa* L.) is commercially propagated by true seeds. Onion seed has short shelf life as seed viability reduced very fast in ordinary storage condition. Farmers have to secure fresh seed for planting each year. However, a major limitation is the limited availability of quality seeds and poor seed replacement rate of onion in India (Gupta and Sharma 2011). Onion seed production might be increased by increasing the area with good variety, superior management practices and by using quality seed. But most of the farmers use own saved seeds for onion cultivation, which were often not produced scientifically following seed multiplication guidelines (Dhar et al 2018). Varietal admixture and heterogeneous material results reduced onion productivity of Indian farmers (Lawande et al 2009). In India, mostly short day cultivars were grown in winter season both for bulb and seed production. Onion is a non-traditional commercial crop of Red and Laterite Zone of West Bengal. In West Bengal, farmers are prefer to grow onion cv. Sukhsagar (an indigenous winter season cultivar)due to its higher production potential, good quality, better storability and adaptability in this region. However, some farmers of this region recently started commercial onion farming. Some of them were also venturing for seed production seeing its good return. However, poor selection of mother bulb and faulty crop management practices often results in crop failure or poor seed quality. Ginoya et al (2018) observed that small farmers have inadequate knowledge for selecting proper grade of the bulbs and plant spacing. The initiation of inflorescence is favoured by a large set or bulb size. Bulb size generally plays an important role in onion seed production (Khokhar 2014). The vegetative growth and seed production ability of the plants increased gradually with the increase in bulb size (Manna et al 2016). El-Damarany et al (2015) observed that bulb size and plant spacing are the key factors in producing onion seeds of high quality. Optimum plant spacing ensures proper growth and development of plant by reducing competition among the plants for nutrients, moisture, space and light, resulting in maximum yield and the best use of land (Kamboj et al 2017). Spacing plays a vital role for maximizing onion seed yield and quality (Sanjay Kumar et al 2015). Research on seed production of onion is meager in West Bengal. Manna et al (2016) standardized planting time and bulb size for onion seed production under New Alluvial Zone of West Bengal. However, study on onion seed production in red and laterite zone of West Bengal is lacking. Considering the importance of bulb size and spacing in onion seed production the present experiment was conducted to determine the effect of mother bulb weight and spacing under Red and Laterite Zone of West Bengal.

MATERIAL AND METHODS

The experiment was conducted at Institute of Agriculture, Sriniketan (West Bengal). The soil of the experiment field was loamy sand with soil pH of 5.8 and organic carbon content 0.54%. The available soil nitrogen, phosphorus and potassium were 201.6 kg, 12.01 kg and 91.57 kg per hectare. The present experiment was conducted by following bulb to seed method. The whole experiment was completed in two years (*Rabi* season of 2015-16 and 2016-17). In first year, bulbs were produced, harvested and stored in a well ventilated room and in the second year, bulbs were transplanted for seed production. In September 2015, seed of onion cv. Sukhsagar were collected from the local progressive farmer. The seeds were sown on 16th October 2015 in nursery beds to raise seedlings for transplanting in the main field. Healthy seedlings were transplanted on 5th December 2015 in the main field when they were 50 days old. FYM @ 25 t/ha with NPK @ 125: 100: 100 kg/ha was applied to grow the bulb crop. Entire dose of FYM, phosphate and potash along with half the dose of N fertilizers was given as basal during final land preparation. The rest N was top dressed in two split doses at 30 and 50 days after transplanting. Further, the crop was grown with necessary cultural operations like regular irrigation, weeding. when required.Irrigation was stopped in 10 days before bulb harvesting. The bulbs were lifted when 75% plant showed neck fall at about 100 days after transplanting. The harvested bulbs were field cured for two days and then cured under naturally ventilated room by spreading in the floor for seven days. The dried leaves were trimmed from neck region leaving 2-3 cm attached with bulb. The damaged, twin and long necked bulbs were discarded. Then the bulbs were graded in three different sizes, small (30-50g), medium (51-65g) and large (65-80g). The graded bulbs were then stored under ambient condition up to November for seed production. During second year in *Rabi* 2016-17, seed production field was well prepared and twenty seven plots of 2.25 m x 1.8 m size were prepared. The same crop nutrition schedule was followed for seed crop as in bulb production *i.e.* FYM @ 25t/ha and NPK @ 125:100:100 kg/ha. The experiment comprising nine treatments was laid out in factorial randomized block design with three replications. The experiment had two factors *i.e.* three spacing (factor A) [S1 (22.5 cm × 30 cm), S2 (30 cm × 30 cm) and S3 (45 cm × 30 cm)] and three mother bulb weight (factor B) [B1 (30-50g), B2 (51-65g) and B3 (66-80g)]. Stored bulbs were sorted and only good quality bulbs which are visually free from any rotting were selected. Upper one third portions of the bulbs were cut to see their internal quality. The cut bulbs were treated with fungicide SAAF (Carbendazim12% + Mancozeb63% WP, UPL Limited, Mumbai) @ 2g/l before planting. Planting was done on 8th November, 2016. The observations were recorded on plant height, number of leaves, neck diameter, number of scape, scape length, scape diameter, umbel diameter and number of flowers per umbel from ten randomly selected plants in each replication. Data on number of seeds per umbel, seed weight per umbel, seed yield per plant and seed yield/plot were taken after umbel harvesting. Seed yield per hectare was computed from the seed yield obtained per plot.Three samples of 1000 seeds was taken, weighed and averaged for getting test weight of seed. The laboratory germination test was conducted as per the ISTA rules (Anonymous, 1996) by adopting Top of paper method. The seed vigour was calculated as Seed vigour = Germination (%) x Seedling length (cm).

RESULTS AND DISCUSSION

Growth traits: Maximum number of leaves per plant was observed in wider spacing of 45cm x 30cm, which was statistically at par with 30cm x 30cm spacing. Less number of leaves in narrower spacing may be ascribed to natural shading and possibly stiffer competition for light as well as other growth factors among onion plant. The findings are similar to Sanjay Kumar et al (2015). Maximum number of leaves was also when bigger bulbs (66-80g or 51-65g) were planted. Larger sized bulbs having more stored foods which support the production of more leaves as compare to small size bulbs. These results are in line with the findings of El-Damarany et al (2015) and Manna et al (2016). Interaction effect of spacing and bulb weight was non-significant for this trait. Plant height and neck diameter were not differed in various levels of spacing, bulb weight and their interactions.

Scape traits: Planting of different sized bulb significantly influenced the number of scape per plant. Scape number, however, was not affected by direct effect of spacing and interaction effect of spacing and bulb weight. Large size bulb (66-80g) produced maximum number of scape per plant. Khokhar (2014) observed that large bulbs produce more flower stalks. Morozowska and Hołubowicz (2009) discovered that the big bulbs gave larger numbers of seed stalks than the seed stalks grown from the medium and small ones. Spacing, bulb weight and their interactions were not influenced the scape length and diameter. Morozowska and Hołubowicz (2009) reported that bulb size had no effect on the seed stalk height or their diameter.

Umbel traits and seeds per plant: Maximum umbel diameter was in wider spacing of 45cm x 30cm and may be due to the less competition among the plant for fertilizer and moisture for growth than the lower spacing. Sanjay Kumar et al (2015) reported that wide plant spacing of 60cm x 30cm showed higher umbel diameter than closer spacing. Bulb weight also influenced the umbel diameter. The planting of large (66-80g) or medium sized bulbs (51-65g) produced greater umber diameter and may be due to more stored food in large size bulbs. Morozowska and Hołubowicz (2009) showed a significant influence of bulb size on the inflorescence diameter. El-Damarany et al (2015) obtained maximum umbel diameter from the large mother bulb (6 >: 7.5cm), which was significantly higher than the medium and small sized bulb. Kocher (2014) observed the large sized bulbs produced the highest umbel diameter followed by the medium size. Interaction effect was non-significant for this trait. Maximum number of flowers per umbel (580.39) was in spacing of 45cm x 30cm. Widest spacing produced more number of flowers probably due to less competition for nutrients, light, space, and moisture. Different bulb sizes showed significantly effect on number of flowers per umbel. The maximum flowers per umbel (543.32) were larger bulbs (66-80g) followed by medium sized bulbs (530.41). Interaction between spacing and bulb sizes was not-significant. Maximum number of seeds per umbel (692.89) was in wider spacing (45cm x 30cm). Kamboj et al (2017) recorded maximum number of seeds per umbel under wide spacing of 60x45 cm and 45x45 cm. Less competition among the plants at widest spacing may encouraged the plants to produce more seeds per umbel. Planting of large (66-80g) and medium size bulbs (51-65g) produced maximum number of seed per umbel. Manna et al (2016) obtained maximum number of seeds per umbel from plants raised from large size bulbs. Interaction effect showed that number of seed per umbel was increased when bigger sized bulbs were planted in wider spacing. These results are in line with the findings of El-Damarany et al (2015). Widest spacing recorded highest number of seeds per and may be due to availability of photosynthates and less competition for nutrients, moisture and light source in widely spaced plants. However, bulb weight did not affect this trait. Interaction effect revealed that planting of small, medium or large sized bulbs in wider spacing (45cm x 30cm) registered maximum seed number. Therefore, it indicated that planting of bulbs in wider spacing is the key to obtain maximum number of seeds per plant.

Seed yield: Maximum seed yield per plant (12.61 g) was in wider plant spacing (45cm x 30cm). Similar results were obtained by Sanjay Kumar et al (2015). Higher seed yield per plant was also obtained by planting large size bulbs (65-80g). Seed yield per plant increased with increases of bulb size due to the more food stored in large bulb than the medium and small size bulb. Similar result was documented by Manna et al (2016). Morozowska and Hołubowicz (2009) observed that if

Table 1. Effect of spacing and bulb weight on growth and flower parameters of onion seed crop

Treatment	Plant height (cm)	Number of leaves	Neck diameter (mm)	Number of scape /plant	Scape length (cm)	Scape diameter (mm)	Umbel diameter (mm)	Number of flowers/umbel
Spacing								
S1	73.15[a]	30.46 [b]	14.91[a]	4.82[a]	82.91[a]	17.29[a]	57.80 [b]	494.76[b]
S2	72.81[a]	33.00 [a]	15.23[a]	4.73 [a]	79.44[a]	16.48[a]	58.89 [b]	469.76[b]
S3	72.24[a]	33.54 [a]	15.47[a]	4.96 [a]	81.50 [a]	17.09[a]	65.34 [a]	580.39 [a]
Bulb size								
B1	72.43[a]	29.19 [b]	15.07[a]	4.38 [b]	79.11[a]	16.93[a]	57.64 [b]	471.17 [b]
B2	73.59[a]	33.39 [a]	15.28[a]	4.46 [b]	82.05[a]	17.01[a]	61.10 [a]	530.41 [a]
B3	72.18[a]	34.43 [a]	15.25[a]	5.67 [a]	82.69[a]	16.93[a]	63.29 [a]	543.32 [a]
Spacing x Bulb size								
S1B1	74.67[a]	27.85[a]	14.44[a]	4.57[a]	82.92[a]	17.31[a]	57.60[a]	476.55[a]
S1B2	72.28[a]	31.07[a]	15.34[a]	4.64[a]	82.74[a]	17.48[a]	57.02[a]	504.43[a]
S1B3	72.51[a]	32.47[a]	14.94[a]	5.25[a]	83.06[a]	17.10[a]	58.78[a]	503.30[a]
S2B1	70.13[a]	28.93[a]	14.73[a]	4.11[a]	74.58[a]	16.28[a]	53.25[a]	370.16[a]
S2B2	76.29[a]	33.55[a]	15.42[a]	4.15[a]	81.78[a]	16.30[a]	60.47[a]	513.34[a]
S2B3	72.01[a]	36.51[a]	15.53[a]	5.93[a]	81.97[a]	16.87[a]	62.96[a]	525.77[a]
S3B1	72.47[a]	30.77[a]	16.04[a]	4.47[a]	79.84[a]	17.19[a]	62.07[a]	566.79[a]
S3B2	72.21[a]	35.54[a]	15.08[a]	4.58[a]	81.63[a]	17.25[a]	65.82[a]	573.47[a]
S3B3	72.04[a]	34.30[a]	15.29[a]	5.83[a]	83.04[a]	16.83[a]	68.14[a]	600.90[a]
Mean	72.73	32.33	15.20	4.84	81.28	16.96	60.68	514.97

Note: Bulb size [B1 (30-50g), B2 (51-65g) and B3 (66-80g)] and Spacing [S1=22.5×30cm, S2=30×30cm and S3=45×30cm];
Means with at least one letter common in a column are statistically *at par* using Fisher's Least Significant Difference

the onion bulbs used were large, the seed yield per plant was twice large as if the bulbs were small. Interaction effect showed that higher seed yield per plant was obtainedwhen 30-50g or 51-65g or 66-80g bulbs were planted in 45cm x 30cm spacing. Wider spacing gave unique opportunity to the individual plants to grow freely without facing competition from nearby plants. Plants eventually produced more seed yield. Ginoya et al (2018) obtained highest seed yield in the plants raised from the largest bulb size (75 g) and at the spacing of 60cm x 40cm. Similarly El-Damarany et al (2015) recorded highest seed yield/plant from the largest bulb size with the widest planting distance.The direct effect of spacing and bulb size and their interaction effects were significant. Maximum seed yield (857.80 kg) was in 30cm x 30cm spacing, but was at par with closest spacing (22.5 cm x 30cm). The minimum seed yield was in widest spacing (45cm x 30cm). Planting of bulbs in lesser spacing accommodate more plants per unit area, which assume to contribute cumulatively towards more yield per unit area. This was opposite to the trait seed yield per plant, where individual contribution increased by increasing spacing. The trend is in accordance to the findings of Kamboj et al (2017), who observed that the lowest seed yield was mainly due to lower plant population per unit area at wider plant spacing. The highest seed yield (923.35kg) was by planting large bulbs (66-80g), which was significantly superior than planting of medium and lessweight bulbs. Larger mother bulb having a larger food supply and water content than the smaller bulbs enables the development of vigorous plants and production of higher seed yields (Khokhar, 2014).El-Damarany et al (2015) and Manna et al (2016) concluded that planting of large size bulb produced significantly higher seed yield than planting medium and small size bulb. Morozowska and Hołubowicz (2009) concluded that for practical seed production, only large onion bulbs count. Maximum seed yield was recorded in combination of 30cm x 30cm spacing and medium size bulbs (51-65g), which was at par with 30cm x30cmspacing and large size bulbs, 22.5cm x 30cm spacing and large size bulbs and 45cm x30cm spacing and large size bulbs. The large bulb size gave maximum seed yield in all three spacing. Thus use of large size mother bulbs assure good seed yield in onion irrespective of spacing. Ginoya et al (2018) observed significantly high seed yield using largest bulb size (75 ± 5g) and medium spacing (45cm x 30cm). Similar observation was recorded by El-Damarany et al (2015).

Seed quality traits: The direct effect of spacing was observednon-significant for 1000 seed weight. Bulb weighthad significant influence on 1000 seed weight, though

Table 2. Effect of spacing and bulb weight on seed yield, its attributes and seed quality of onion

Treatment	Number of seeds /umbel	Number of seeds /plant	Seed weight /umbel (g)	Seed yield /plant (g)	Seed yield /ha (kg)	1000 seed weight (g)	Seed germination (%)	Seedling length (cm)	Seed vigour
Spacing									
S1	574.11 ^{b}	2530.77^{b}	2.02^{a}	8.93^{b}	855.34 ^{a}	3.56^{a}	82.44^{a}	5.68^{b}	470.37^{a}
S2	571.00 ^{b}	2500.71^{b}	2.07^{a}	9.07^{b}	873.80 ^{a}	3.62^{a}	86.00^{a}	5.67^{b}	487.80^{a}
S3	692.89 ^{a}	3441.50^{a}	2.41^{a}	12.61^{a}	717.83 ^{b}	3.67^{a}	84.44^{a}	6.73^{a}	568.55^{a}
Bulb size									
B1	585.00 ^{b}	2732.93^{a}	2.12^{a}	9.92^{b}	695.14 ^{c}	3.65 ^{a}	81.78^{b}	5.72^{a}	467.53^{a}
B2	621.33 ^{a}	2803.24^{a}	2.16^{a}	9.75^{b}	828.48 ^{b}	3.46 ^{b}	82.89^{b}	6.15^{a}	511.99^{a}
B3	631.67 ^{a}	2936.80^{a}	2.22^{a}	10.94^{a}	923.35^{a}	3.73 ^{a}	88.22^{a}	6.22^{a}	547.20^{a}
Spacing x Bulb size									
S1B1	576.67 ^{cd}	2611.53^{cd}	2.05^{a}	9.28^{c}	843.54 ^{bc}	3.64 ^{abc}	79.33^{a}	6.15^{a}	488.55^{a}
S1B2	574.67 ^{cd}	2469.10^{d}	1.88^{a}	8.09^{c}	792.76 ^{cd}	3.28 ^{d}	80.67^{a}	4.77^{a}	386.16^{a}
S1B3	571.00 ^{cd}	2511.67^{d}	2.14^{a}	9.43^{c}	929.71 ^{ab}	3.76 ^{ab}	87.33^{a}	6.13^{a}	536.40^{a}
S2B1	541.33 ^{e}	2282.53^{d}	1.93^{a}	8.06^{c}	665.93 ^{ef}	3.56 ^{bc}	82.67^{a}	5.07^{a}	419.89^{a}
S2B2	570.33 ^{c}	2244.53^{d}	2.01^{a}	7.90^{c}	1002.14 ^{a}	3.52 ^{c}	84.00^{a}	6.46^{a}	542.36^{a}
S2B3	601.33 ^{bc}	2975.07^{bc}	2.28^{a}	11.25^{b}	953.33 ^{ab}	3.79 ^{a}	91.33^{a}	5.49^{a}	501.15^{a}
S3B1	637.00 ^{b}	3304.73^{ab}	2.40^{a}	12.42^{ab}	575.97 ^{f}	3.76^{ab}	83.33^{a}	5.94^{a}	494.16^{a}
S3B2	719.00 ^{a}	3696.09^{a}	2.58^{a}	13.27^{a}	690.53 ^{de}	3.59^{abc}	84.00^{a}	7.21^{a}	607.44^{a}
S3B3	722.67 ^{a}	3323.67^{ab}	2.24^{a}	12.14^{ab}	887.00 ^{abc}	3.65 ^{abc}	86.00^{a}	7.03^{a}	604.05^{a}
Mean	612.67	2824.32	2.17	10.20	815.66	3.62	84.30	6.03	508.91

See Table 1 for details

the reason was unclear as larger and smaller sized bulbs had higher 1000 seed weight than medium sized bulbs. El-Damarany et al (2015) obtainedhigher 1000 seed weight using larger mother bulbs. They assume that the superiority of large bulbs may be related to its higher food reserves. Khokhar (2014) observed significant increase in 1000-seed weight with the increase in bulb size. Interaction between spacing and mother bulb weight showed that various treatment combination gave higher 1000 seed weight. However, no definite trend was noticed. The spacing did not affect percent seed germination. However, seeds obtained by planting 66-80g bulbs had maximum percent germination (88.22%) than medium and small sized bulbs. Similar trend was noted by El-Damarany et al (2015). They observed maximum germination percentage (87.45%) using large mother bulbs. No significant interaction was noted between spacing and bulb size for this trait.Plant spacing influenced the seedling length. Wider spacing (45 x 30cm) produced longest seedlings. Sanjay Kumar et al (2015) also recorded maximum seedling length in wider spacing. Direct effect of bulb weight and interaction between spacing and bulb weight was statistically non-significant for this trait. However, seed vigour was not influenced by direct and interaction effects of spacing and bulb weight.

CONCLUSION

The plant spacing and mother bulb weight largely influenced the seed yield and quality of onion. Planting medium size bulbs (51-65g) in 30×30cm spacing can be followed to obtain high seed yield. Alternately planting of larger sized bulbs (66-80g) at any spacing ensures high seed yield in onion. Planting of large sized bulbs also helped to get seeds with high germination.

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