ISSN 0258-7122 (Print), 2408-8293 (Online)
Bangladesh J. Agril. Res. 48(4): 501-512, December 2023

EFFECT OF VARIETY AND SEED RATE ON YIELD AND QUALITY OF ONION (*Allium cepa* L.) SETS

M. A. KHAN[1], M. M. RAHMAN[2] AND R. SARKER[3]

Abstract

A field study was carried out at Spices Research Sub-Centre, Bangladesh Agricultural Research Institute, Faridpur in 2021-2022. The experiment was conducted to find out suitable variety and optimum seed rate for producing onion sets. The treatment consisted of four varieties viz. BARI Piaz-1, BARI Piaz-4, BARI Piaz-6 and LalTeer king and six seeding rate like 2g ^{2}, 4g , 6g , 8g^2, 10g seeds/m^2 and transplanting of seedlings densely (average 240 seedlings/m^2). The trial was laid out in a randomized complete block design with three replications. The result revealed that significant differences were found in all studied characters due to variety but exception, seed rate and their combined effect. The variety BARI Piaz-1 had the highest optimum sets (60.64%). The maximum bolting were counted from BARI Piaz-1 (2.96%) followed by BARI Piaz-6 (2.33%). LalTeer King produced the highest set yield (13.57t/ha). Onion sets were delay matured (154 days) in transplanting method. Seeding 10g/m^2 took the lowest time to mature of onion sets (130 days). The highest optimum set was obtained from seeding 6g/m^2 (65.74%). The set yield was increased with the increase in seeding rate up to 8g/m^2 and thereafter decreased. Finally, onion var. BARI Piaz-4 and BARI Piaz-6 are suitable for producing optimum onion sets with good yield of onion at 4-6g/m^2 seed rate.

Keywords: Variety, Seed rate, Yield, Quality, Onion sets

Introduction

Onion (*Allium cepa* L.) stands first among the spice crops in Bangladesh. Onion cultivation area in the country is about 0.194 million hectare with a total production of 2.269 million metric tonnes per annum. Average yield of onion is low, being 11.67 t/ha (BBS, 2022) as compared to India where 16.80 t/ha (NHB, 2019). The government of Bangladesh imports about 1.0 million metric tonnes of onion per year expending a huge foreign currency for meeting the demand of the country (Khan *et al*., 2020). About 25-35% onions are produced in the country through set to bulb method (Khan *et al*., 2023). Onions are largely planted as sets in many countries (Khokhar *et al*., 2002). Traditionally set is grown done in different districts such as Faridpur, Shariatpur, Rajbari, Pabna, Madaripur, Manikganj for growing only green onions but not for store purpose. Optimum set was found 3.5-6.5g for planting which are produced in previous season by seeding thickly for getting early crop (Khan *et al*., 2021). Farmers produce their sets using different

[1]Principal Scientific Officer, Spices Research Sub-Centre (SRSC), Bangladesh Agricultural Research Institute (BARI), Faridpur and [2&3]Scientific Officer, SRSC, BARI, Faridpur, Bangladesh.

rate of true seeds. The growth, yield and quality of onion sets are not only influenced by seed rate but also variety (Mohammedali *et al*., 2022). Onion sets are influenced by cultivar, density and environmental conditions (Ansari, 2007). In Bangladesh, onion growers previously used only BARI Piaz-1 to produce onion through set method due to lack of other suitable varieties. Many alternative varieties viz. BARI Piaz-4, BARI Piaz-6 and LalTeer King are available at present. Scanty study was found earlier in Bangladesh with seed rate and variety for production of onion sets. The present experiment was, therefore, undertaken to find out optimum seed rate for getting desirable sets of onion varieties in producing onion sets in Bangladesh.

Materials and Methods

The study was conducted at Spices Research Sub-Centre, Bangladesh Agricultural Research Institute, Faridpur, Bangladesh during rabi season of 2021-2022 to find out optimum seed rate of onion varieties for getting quality onion sets (bulblets). The trial was carried out with four varieties viz. as V_1 = BARI Piaz-1, V_2 = BARI Piaz-4, V_3 = BARI Piaz-6 and V_4 = LalTeer king, and six seeding rate like as S_1 = 2g seeds/m^2, S_2 = 4g seeds/m^2, S_3 = 6g seeds/m^2, S_4 = 8g seeds/m^2, S_5 = 10g seeds/m^2 and S_6 = transplanting of seedlings densely (average 240 seedlings/m^2). Average thousand-seed weight of BARI Piaz-1, BARI Piaz-4, BARI Piaz-6 and LalTeer King were 3.14g, 3.42g, 2.87g and 3.89g, respectively. True seeds of onion were sown in the raised plot as per treatment. Sowing date for all treatments was 6 November 2021. Germination percent of those varieties were 90.21, 93.12, 86.97 and 97.76%, respectively. Transplanting was done densely (about 240 plants/m^2) on 15 December 2021 with 40-day old uniform and healthy seedlings for the treatment S_6. The experiment was laid out in randomized complete block design with three replications. The unit plot size was 3.00 m x 1.00 m for each treatment. The experimental field was fertilized with 3000 kg well-decomposed cowdung, 220 kg Urea, 220 kg Triple super phosphate (TSP), 150 kg Muriate of potash (MOP), 110 kg Gypsum and 8 kg Boron fertilizer (solubor) per hectare. The entire quantity of cowdung, TSP, MOP, gypsum, boron and one third of urea were applied as basal during land preparation. The remaining urea was dressed in two equal splits on 5 January 2021 and 25 January 2022. All other recommended management practices (weeding, spraying of pesticides, irrigation etc.) were followed for each treatment. The data was recorded on plant height, number of leaves per plant, number of plants per square meter, percent of bolting, days to maturity of sets, polar and equatorial diameter of set, percent of undersized set, percent optimum set, percent medium set, percent oversized set, shape index, individual set weight, dry matter content of sets and set weight. Set yield was calculated and expressed in t/ha. The number of plants per square meter (population density) was counted at bulbing stage. The sets were harvested at maturity following the method of Brewster (2008) on several dates. The sets were matured when more than 80% neck fall and drying up of plants. The leaves of harvested onion were removed at seven days after shade curing by cutting 2.0-2.5

cm above the bulb (Brewster, 2008). Total fresh weight of sets was measured for each plot after curing as per method of Brewster (2008). Shape index of set is the ratio of set height (polar diameter) to equatorial diameter. The dry matter content of bulbs was calculated by dry weight basis as per procedure of Walle *et al*. (2018). The sets were categorized into four sizes as optimum (3.5-6.5g), medium (7-14g), undersized (<4g) and oversized (>14g) after counting the number of sets. The recorded data was analyzed statistically as suggested by Gomez and Gomez (1984). The means were compared by the Least Significant Difference (LSD) test.

Results and Discussion

Effects of variety

The variety had significant influence on the studied parameters except number of leaves per plant and individual set weight (Table 1 & 2). The maximum number of plants/m^2 (450) was observed in LalTeer King followed by BARI Piaz-4 (424). Significantly the lowest number of plants/m^2 (387) was obtained from BARI Piaz-1. Probable causes of variation in population density among the varieties might be due to thousand seed weight and percent germination of seeds. The variety LalTeer King exhibited the maximum plant height (53cm) followed by BARI Piaz-4 (51cm). The lowest plant height was recorded in BARI Piaz-1 (45cm). The variation in plant height could be attributed due to genetic inheritance among the varieties. Number of leaves was not responded by the variety but Mandal *et al*. (2018) observed significant difference in this character among the varieties. The var. BARI Piaz-4 required the maximum days to maturity of set (138 days) followed by LalTeer King (137 days) and BARI Piaz-1 (136 days). The variety BARI Piaz-6 had the minimum days to maturity of sets (134 days). The variation of days to maturity might be due to genetic character among the varieties. The results are in lines with the findings of Khan *et al*. (2022), Walle *et al*. (2038) and Arya *et al*. (2017).

Equatorial diameter of set ranged from 25.22mm to 26.91mm with the highest diameter at LalTeer King and the lowest at BARI Piaz-1. This variation was probably due to the genetic make-up of variety. Similar findings on the variation of diameter were also found by Mandal *et al*. (2018) and Ansari (2007). Insignificant variation was found on the individual set weight among the varieties which was differed by the results of Mandal *et al*. (2018) and Mohammedali *et al*. (2022). The highest dry matter of set was produced in BARI Piaz-1 (19.38%) which was statistically differed with other varieties.

The var. BARI Piaz-1 showed the maximum value of bolting (2.96%) which was identical to BARI Piaz-4 (2.76%) and LalTeer King (2.72%) but significantly different from BARI Piaz-6 (2.33%). The variety BARI Piaz-4 had the maximum shape index (1.49) and the minimum in BARI Piaz-1 (0.98). The results admitted the findings of others (Khan *et al*., 2022) who opined that shape index was governed by variety.

Table 1. Effect of variety on plants/m^2, plant height, leaves/plant, days to maturity, set diameter, individual set weight and dry matter of onion sets (2021-2022)

Variety	Plants/m^2(no.)	Plant height (cm)	Leaves /plant (no.)	Days to maturity	Set diameter (mm)	Individual set weight (g)	Dry matter of set (%)
BARI Piaz-1	387	45	5.92	136	25.22	7.46	19.38
BARI Piaz-4	424	51	5.66	138	26.82	7.79	15.42
BARI Piaz-6	371	50	5.89	134	26.22	7.50	15.72
LalTeer king	450	53	5.77	137	26.91	7.99	15.33
LSD (0.05)	74.35	2.16	NS	1.22	1.33	NS	0.50
CV (%)	27.18	6.46	9.85	1.34	7.49	10.66	4.54

Table 2. Effect of variety on bolting, shape index, optimum set, medium set, oversized set, undersized set and yield of onion sets (2021-2022)

Variety	Bolting (%)	Shape index	Optimum set (%)	Medium set (%)	Oversized set (%)	Undersized set (%)	Set yield (t/ha)
BARI Piaz-1	2.96	0.98	60.64	19.11	5.62	14.61	11.65
BARI Piaz-4	2.76	1.49	57.53	15.23	9.53	17.69	12.86
BARI Piaz-6	2.33	1.29	57.50	16.66	6.28	19.54	12.24
LalTeer king	2.72	1.22	51.07	20.67	6.75	21.50	13.57
LSD (0.05)	0.47	0.07	1.59	1.31	0.90	1.26	0.55
CV (%)	26.22	8.35	4.17	10.89	19.03	10.26	6.46

The highest percent of optimum set size was recorded from BARI Piaz-1 (60.64%) while significantly the lowest percent of optimum set size (51.07%) in LalTeer King. The highest percent of medium set was obtained from LalTeer King (20.67%) while the lowest from BARI Piaz-4 (15.23%). The highest oversized set was found in BARI Piaz-4 (9.53(%) while e lowest in BARI Piaz-1 (5.62%). The undersized set ranged from 14.61 to 21.50% with the highest value in LalTeer King and lowest in BARI Piaz-1. The variation in set size might be due to characteristics of variety. Consistent results were found on the percent of set size by Mohammedali *et al*. (2022) and Mandal *et al*. (2018). The variety LalTeer King produced the maximum set yield (13.57t/ha) followed by BARI Piaz-4 (12.86t/ha) and BARI Piaz-6 (12.24t/ha). The minimum set yield was obtained from BARI Piaz-1 (11.65t/ha). The results agreed with the findings of Mohammedali *et al*. (2022) and Mandal *et al*. (2018).

Effect of seed rate

The seeding rates exerted significant influence on the studied characters on onion (Table 3 & 4). The highest number of plants/m^2 (620.57) was noticed in seeding @ 10g/m^2 (S_5) and lowest value (160.21) at seeding @ 2g/m^2 (S_1). The results confirmed the finding of Mohamed *et al*. (2012). Transplanting of seedlings gave the tallest plant height (53.57cm) which was followed by seeding @ 2g seeds/m^2 (51.05cm). On the other hand, seeding @ 10g seeds/m^2 produced the shortest plant height (46.07cm). It might be due to increased completion for nutrients, light, space and moisture. The results corroborated the previous findings of Aliyu *et al*. (2008).

The maximum number of leaves per plant was counted in transplanting method (6.69) followed by seeding @ 2g/m^2 (6.17). However, the lowest number of leaves was recorded from seeding @ 10g/m^2 (5.17). The widest plant spacing (lower plant density) produced the maximum plant height and leaves per plant (Jilani *et al*., 2010; Shock *et al*., 2004 and Khan *et al*., 2003).

Transplanting of seedlings required maximum time to mature of sets (154 days) followed by seeding @ 2g/m^2 (136 days). The minimum time was needed to mature of sets for seeding @ 10g/m^2 (130 days). Transplanted set were deeper in the soil while direct seeded onions developed at or near the soil surface (Boyhan *et al*., 2008). For these aforesaid reasons, transplanted plants are better able to survive as compared with direct seeded onions, also described by Boyhan *et al*. (2008). Macias-Duarte *et al*. (2004) observed earlier maturity in direct seeding in comparing to the transplanted method. Ketema *et al*. (2013) and Motallebi *et al*. (2001) stated that maturity was significantly more delayed in direct seeding method than that of transplant. Days to maturity decreased as density increased (Anonymous, 2010 and Brewster, 2008).

Table 3. Effect of seed rate on plants/m^2, plant height, leaves/plant, days to maturity, set diameter, individual set weight and dry matter of onion sets (2021-2022)

Seed rate	Plants/m^2 (no.)	Plant height (cm)	Leaves /plant (no.)	Days to maturity (days)	Set diameter (mm)	Individual set weight (g)	Dry matter of set (%)
S_1=2g seeds/m^2	160.21	51.05	6.17	136	29.96	12.03	15.93
S_2=4g seeds/m^2	375.02	49.95	5.77	135	27.82	8.81	15.99
S_3=6g seeds/m^2	476.26	49.45	5.63	133	26.73	6.59	16.44
S_4=8g seeds/m^2	573.92	49.15	5.45	131	24.83	5.02	16.66
S_5=10g seeds/m^2	620.57	46.07	5.17	130	21.14	3.23	16.77
S_6=Transplanted seedlings	240.66	53.57	6.69	154	28.32	10.42	16.99
LSD (0.05)	91.07	2.65	0.48	1.50	1.62	0.67	0.61
CV (%)	27.18	6.46	9.85	1.34	7.49	10.66	4.54

Table 4. Effect of seed rate on bolting, shape index, optimum set, medium set, oversized set, undersized set and yield of onion sets (2021-2022)

Seed rate	Bolting (%)	Shape index	Optimum set (%)	Medium set (%)	Oversized set (%)	Undersized set (%)	Set yield (t/ha)
S_1=2g seeds/m^2	3.72	1.10	42.02	27.65	19.92	10.40	9.71
S_2=4g seeds/m^2	2.01	1.19	61.15	17.17	6.31	15.35	12.00
S_3=6g seeds/m^2	1.71	1.27	65.74	13.79	3.01	17.45	13.29
S_4=8g seeds/m^2	1.16	1.36	58.55	12.52	4.56	24.36	14.34
S_5=10g seeds/m^2	1.07	1.38	52.06	13.64	1.13	33.15	12.62
S_6=Transplanted seedlings	6.48	1.16	60.59	22.74	7.36	9.29	13.50
LSD (0.05)	0.58	0.09	1.94	1.60	1.10	1.54	0.66
CV (%)	26.22	8.35	4.17	10.89	19.03	10.26	6.46

The equatorial set diameter ranged from 21.14mm to 29.96mm with the highest in seeding @ 2g/m^2 and the lowest in seeding @ 10g/m^2. The highest value of set diameter differed significantly with the value of transplanting seedlings (28.32mm). Set/bulb size decreased as density increased (Anonymous, 2010; Hamam *et al*., 2012 and Shock *et al*., 2015). The results disagreed with the findings of Ansari (2007) who did not found decreased size of sets with the increase of seeding rate. Seed rate of 2g/m^2 gave the highest individual seed weight (12.03g) followed by transplanted (10.42g) and the lowest set weight in seeding @ 10g/m^2 (3.23g). The results e similar to the findings of (Mohammedali *et al*., 2022 and Mohamed *et al*., 2012) on set/bulb weight. The proportion of small bulbs was increased with the increase in plant density (Shock *et al*., 2015). As plant population increases, onion bulb yield also increases because the leaf canopy intercepts a higher percentage of light (Brewster, 2008).

Transplanting seedlings exhibited the highest dry matter of sets (16.99%) and the lowest dry matter in seeding 2g/m^2 (15.93%). The findings of Ketema *et al*. (2018) and Izadkhan *et al*. (2009) opined that mean dry weight of onion bulb was higher with transplanting seedlings than that of direct seeding. Plants in transplanting method were attributed to stronger photosynthetic efficiency and vigorous vegetative growth due to better establishment which resulted in maximum dry matter content in the bulb of transplant (Ketema *et al*., 2013).

The maximum value of bolting was occurred in transplanting seedling (6.48%) followed by seeding @ 2g/m^2 (3.72%) but the lowest value of bolting in seeding 10g/m^2 (1.07%). Maximum incidence of bolting was found in transplanting as compared to that of direct seeding (Ketema *et al*., 2013).

The greatest shape index was computed in seeding 10g/m^2 (1.38) which was in statistical parity with seeding @ 8g/m^2 (1.36). However, the smallest shape index was calculated in seeding @ 2g/m^2 (1.10). Higher shape index means lower equatorial diameter and higher polar diameter. An increase in plant population leaded to elongated bulbs (Hygrotech, 2010).

The maximum percent of optimum set was obtained from seed rate of 6g/m^2 (65.74%) and seeding 2g/m^2 had the lowest percent of optimum set (42.02%). Sowing seeds @ 2g/m^2 showed the maximum medium set (27.65%) followed by transplanting seedlings (22.74%). However, the lowest percent medium set was recorded from seeding 8g/m^2 (12.52%). Seeding 2g/m^2 demonstrated the maximum oversized set (19.92%) and sowing seeds @ 10g/m^2 had the minimum oversized sets (1.13%). Seeding 10g/m^2 provided the maximum undersized set (33.15%) which was significantly followed by seeding 8g/m^2 (24.36%). Increasing seed rate decreased significantly the percent of large set size as described by Mohammedali *et al*. (2022).

The set yield was increased with the increase in seeding rate up to 8g/m^2 and thereafter the set yield was decreased. Seeding 8g/m^2 gave the maximum set yield

(14.34t/ha) followed by transplanting seedlings (13.50t/ha) while lowest set yield (9.71t/ha) in sowing seeds @ 2g/m^2. Decreased yield from seeding 10g/m^2 might be due to smaller set in seeding 10g/m^2. The present finding also was at par with the results of Mohammedali *et al*. (2022). Yield was positively associated with density of onion plants (Shock *et al*., 2015).

Combined effect of variety and seed rate

The combined effect was found statistically significant variation in all studied traits (Table 5 & 6). The combination of V_4 x S_5 exhibited the maximum number of plants/m^2 (698.26) but V_3 x S_1 had the minimum number of plants/m^2 (140.84). The tallest plant height (56.02cm) was recorded from V_4 x S_6 while V_1 x S_5 showed the shortest plant height (42.49cm). The maximum number of leaves/plant was obtained in the combination of V_1 x S_6 (6.89) while minimum number from V_2 x S_5 (5.01).

The interaction of V_2 x S_6 required the maximum time (156 days) for maturity of sets followed by the combination of V_4 x S_6 (155 days). But the V_3 x S_5 took the minimum time to mature of sets (128 days). The largest equatorial diameter of set was recorded from V_4 x S_1 (31.24mm) and the smallest diameter was obtained under V_1 x S_5 (20.12mm). The interaction of V_4 x S_1 gave the heaviest individual set weight (12.55g) followed by V_2 x S_1 (12.45g) while lightest set in the combination of V_3 x S_5 (2.94g). Similar results were observed by Mohammedali *et al*. (2022) who stated that interaction effect of cultivars and seed rate was statistically significant on single set weight. The V_1 x S_6 (transplanting of seedlings) produced the highest dry matter of set and V_3 x S_1 yielded the lowest dry matter of set (14.41%).

The combination of V_1 x S_6 showed the maximum value of bolting (7.73%) but V_2 x S_5 gave the lowest value of bolting (0.92%). Whereas, V_2 x S_5 expressed the greatest shape index (1.64) and the smallest shape index from the combination of V_1 x S_1 (0.85). The maximum optimum set (78.10%) was recorded from V_1 x S_2 followed by V_1 x S_3 (74.96%). Nonetheless, the V_1 x S_1 produced the lowest percent of optimum set (36.39%). The combination of V_1 x S_6 had the maximum medium set (33.80%) followed by V_4 x S_6 (33.56%). The minimum medium set (5.61%) was counted from the combination of V_2 x S_4. The more percent of oversized set (23.23%) was recorded from the combination of V_4 x S_1 and the smallest oversized set (0.24%) from V_4 x S_5. The interaction of V_4 x S_5 generated the maximum undersized set (45.42%) but the V_2 x S_1 had the lowest undersized set (5.27%). The combination of V_4 x S_4 out yielded (15.16 t/ha) all treatment combinations followed by the combination of V_4 x S_3 (14.49 t/ha). However, the combination of V_1 x S_1 gave the lowest set yield (8.35t/ha). Quality parameters of onion sets are: single set (non-splitting), non-bolter, higher dry matter, well matured, properly cured, without molding, bruising & decaying and optimum size (3.5-6.5g).

Table 5. Combined effect of variety and seed rate on plants/m^2, plant height, leaves/plant, days to maturity, set diameter, individual set weight and dry matter of onion sets (2021-2022)

Variety x seed rate	Plants/m^2 (no.)	Plant height (cm)	Leaves /plant (no.)	Days to maturity	Set diameter (mm)	Individual set weight (g)	Dry matter of set (%)
V_1S_1	144.85	45.96	6.68	135	28.43	11.42	18.82
V_1S_2	371.19	44.15	5.81	135	27.71	8.84	19.20
V_1S_3	402.53	43.69	5.54	133	26.02	6.02	19.30
V_1S_4	623.58	45.95	5.48	132	24.90	4.61	19.44
V_1S_5	535.94	42.49	5.14	129	20.12	3.52	19.62
V_1S_6	245.62	50.42	6.89	153	28.39	10.33	19.95
V_2S_1	158.28	53.08	5.94	137	30.98	12.45	15.77
V_2S_2	387.83	50.55	5.41	136	27.88	8.78	14.83
V_2S_3	551.30	50.55	5.34	135	27.78	6.94	15.11
V_2S_4	563.78	47.55	5.41	132	24.34	5.12	15.35
V_2S_5	641.97	46.69	5.01	131	21.82	3.07	15.63
V_2S_6	238.83	55.95	6.88	156	28.10	10.42	15.84
V_3S_1	140.84	51.48	6.14	134	29.18	11.69	14.41
V_3S_2	349.16	50.62	6.14	132	27.65	8.16	14.88
V_3S_3	389.83	50.02	5.88	133	26.21	6.35	16.16
V_3S_4	501.08	49.55	5.34	129	24.66	5.01	16.28
V_3S_5	606.13	47.28	5.11	128	21.09	2.94	16.30
V_3S_6	236.10	51.88	6.74	153	28.51	10.87	16.340
V_4S_1	196.85	53.68	5.94	136	31.24	12.55	14.75
V_4S_2	391.89	54.48	5.74	135	28.06	9.47	15.08
V_4S_3	561.36	53.55	5.74	134	26.93	7.05	15.22
V_4S_4	607.22	53.55	5.55	132	25.41	5.33	15.60
V_4S_5	698.26	47.82	5.41	131	21.55	3.50	15.53
V_4S_6	242.08	56.02	6.28	155	28.28	10.04	15.84
LSD (0.05)	105.17	3.02	0.57	2.33	1.97	0.95	0.89
CV (%)	27.18	6.46	9.85	1.34	7.49	10.66	4.54

Footnote: V_1 = BARI Piaz-1, V_2 = BARI Piaz-4, V_3 = BARI Piaz-6 and V_4 = LalTeer king and six seeding rate viz. S_1 = 2g seeds/m^2, S_2 = 4g seeds/m^2, S_3 = 6g seeds/m^2, S_4 = 8g seeds/m^2, S_5 = 10g seeds/m^2 and S_6 = transplanting of seedlings densely

Table 6. Combined effect of variety and seed rate on bolting, shape index, optimum set, medium set, oversized set, undersized set and yield of onion sets (2021-2022)

Variety x seed rate	Bolting (%)	Shape index	Optimum set (%)	Medium set (%)	Oversized set (%)	Undersized set (%)	Set yield (t/ha)
V_1S_1	4.37	0.85	36.39	32.93	18.70	11.97	8.35
V_1S_2	2.01	0.91	78.10	9.26	2.24	10.38	10.99
V_1S_3	1.49	1.01	74.96	10.69	1.54	12.81	12.53
V_1S_4	1.13	1.09	62.71	9.69	6.30	21.30	13.75
V_1S_5	1.03	1.10	57.69	18.29	1.41	22.61	12.03
V_1S_6	7.73	0.93	54.03	33.80	3.58	8.59	12.26
V_2S_1	3.86	1.38	42.91	29.82	22.00	5.27	10.19
V_2S_2	2.13	1.42	50.65	19.98	12.18	17.19	12.20
V_2S_3	2.01	1.50	61.73	13.34	2.27	22.66	13.35
V_2S_4	1.12	1.60	64.45	5.61	3.90	26.04	14.43
V_2S_5	0.92	1.64	61.69	11.22	1.88	25.21	12.64
V_2S_6	6.52	1.40	63.78	11.41	15.00	9.81	14.34
V_3S_1	2.87	1.10	52.95	15.28	15.75	16.02	9.55
V_3S_2	1.99	1.27	59.54	20.46	1.65	18.35	11.62
V_3S_3	1.48	1.30	63.12	15.69	5.12	16.07	12.79
V_3S_4	1.13	1.45	52.90	21.46	5.22	20.42	14.03
V_3S_5	1.03	1.47	44.69	14.93	1.02	39.36	12.39
V_3S_6	5.51	1.17	71.82	12.19	8.97	7.02l	13.05
V_4S_1	3.79	1.09	35.84	32.57	23.23	8.36	10.75
V_4S_2	1.94	1.19	56.33	19.00	9.17	15.50	13.19
V_4S_3	1.86	1.28	63.17	15.45	3.11	18.27	14.49
V_4S_4	1.26	1.30	54.14	13.32	2.85	29.69	15.16
V_4S_5	1.32	1.34	44.19	10.15	0.24	45.42	13.40
V_4S_6	6.18	1.17	52.75	33.56	1.91	11.77	14.36
LSD (0.05)	0.96	0.12	3.04	2.81	2.13	2.61	1.21
CV (%)	26.22	8.35	4.17	10.89	19.03	10.26	6.46

Footnote: Footnote: V_1 = BARI Piaz-1, V_2 = BARI Piaz-4, V_3 = BARI Piaz-6 and V_4 = LalTeer king and six seeding rate viz. S_1 = 2g seeds/m^2, S_2 = 4g seeds/m^2, S_3 = 6g seeds/m^2, S_4 = 8g seeds/m^2, S_5 = 10g seeds/m^2 and S_6 = transplanting of seedlings densely, Optimum bulb = 3.5-6.5g, medium bulb = 7-14g, oversized bulb = >14g and undersized bulb = <4g.

Conclusion

The highest optimum sets were obtained from seeding 4-6g/m^2. Transplanting method took long time to mature of onion sets. The set yield was increased with the increase in seeding rate up to 8g/m^2 and thereafter the set yield was decreased. The var. BARI Piaz-1, BARI Piaz-4 and BARI Piaz-6 are also suitable for producing optimum onion sets with good yield of onion at 4-6g/m^2 seed rate. In combined effect, BARI Piaz-1 had the highest optimum set with 4-6g seeds/m^2.

References

Aliyu, U., A. Dikko., M. D. Magaji and A. Singh. 2008. Nitrogen and intra-row spacing effect on growth and yield of onion (*Allium cepa* L.). *J. Plant Sci*. **3(3):**188-193.

Anonymous, 2010. Vegetable Production Guides. Oregon State University, College of Agricultural Science, Department of Horticulture., Oregon, USA.

Ansari, N. A. 2007.Effect of density, cultivars and sowing date on onion set production. *Asian J. Plant Sci.* **6(7):**1147-1150.

Arya, J. S., N. Singh., P. S. Arya and A. Kant. 2017. Morphological variations and relationship among onion germplasm for quantitative and qualitative traits at trans-Himalaya Ladakh, India. *Aus. J. Crop Sci*. **11(3):**319-337.

BBS (Bangladesh Bureau of Statistics). 2022. Yearbook of Agricultural Statistics of Bangladesh-2021. 33rd Series, May 2022. Bangladesh Bureau of Statistics, Statistics & Informatics Division, Ministry of planning, Government of the People's Republic of Bangladesh, p. 138.

Boyhan, G. E., J. C. Diaz-Perez., C. Hopkins., R. L. Torrance and C. R. Hill. 2008. Direct seeding short-day onions in Southeastern Georgia. HortTechnology, **18(3):**349-355.

Brewster, J. L. 2008. Onions and Other Vegetable Alliums. 2nd edition, CAB International, Wallingford, No. 15, 454p.

Gomez, K. A. and A. A. 1984. Statistical Procedures for Agricultural Research (2nd edition). John Wiley and Sons, New York, USA, 680p.

Hamam, M., S. Yacoub., M. Abdalla and R. Gamal. 2012. Yield and quality of onion sets as affected by seeding rate and planting date under Assiut conditions. *Assiut J. Agril. Sci*. **43(1):**24-44.

Hygrotech, 2010. Production guidelines of onions. Hygrotech Sustainable Solutions. Hygrotech, Pretoria, South Africa. www.hygrotech.com.

Izadkhan, M., M. Tajbakhsh., A. Hasnzadeand and S. A. Moosavezade. 2009. Study effects of different planting systems on marketable yield, grading and some bulb quality traits in onion (*Allium cepa* L.). *Online Int. J. Agron. & Bio*. **2(7):**366-369.

Jilani, M. S., P. Ahmed., K. Waseem and M. Kiran. 2010. Effect of plant spacing on growth and yield of two varieties of onion (*Allium cepa* L.), *Pakistan J. Sci*. **62(1):**37- 41.

Ketema, S., L. Dessalegn and B. Tesfaye. 2013. Effect of planting methods on maturity and yield of onion (*Allium cepa* var. *cepa*) in the central rift valley of Ethiopia. *Ethiopia J. Agric. Sci.* **24**:45-55.

Ketema, S., L. Dessalegn and B. Tesfaye. 2018. Effect of planting methods on growth of onion (*Allium cepa* var. *cepa*). *Advances in Applied Physio*. **3(1):**8-13.

Khan, M. A., M. M. Rahman and S. Rinky. 2021. Effects of set size and plant population density on the yield attributes, yield and quality of onion (*Allium cepa* L.). *North American Acad. Res. J*. **4(7):**93-109.

Khan, M. A., M. M. Rahman., S. N. Mozumdar and M. I. Haque. 2020. Strategies for increasing storability of onion (in Bengali). A Folder, Spices Research Sub-Centre, Bangladesh Agricultural Research Institute, Faridpur. Publication No. SRSC/BARI/Farid.01/2020, p.3-8.

Khan, M. A., M. M. Rahman., S. N. Mozumder and R. Sarker. 2023. Performance of varieties on the yield and quality of onion (*Allium cepa* L.) through set to bulb method. *J. Exp. Agri. Intern*. **45(10):**349-354.

Khan, M. A., M. M. Rahman., S. N. Mozumder., M. A. Alam., M. N. A. Choudhury and M. I. Haque. 2022. Performance of eveluation of short-day onion (*Allium cepa* L.) genotypes. *North American Academic Res*. **5(10):**54-69.

Khokhar, K. M., S. I. Hussain., T. Mahmood., Hidayatullah and M. H. Laghari. 2002. Bulb yield and quality as affected by set size in autuman season onion crop. *Asian J. Plant Sci*. **1**:657-658.

Macias-Duarte, R., R. L. Grijalva-Contreras., M. de J. Valenzuela-Ruiz and F. Robles-Contreras. 2004. Yield and quality of onion varieties under direct seed and transplant seedling. *Hort Science Abstracts*. **39(4):**801.

Mandal, J.; P. Acharyya; W. D. Singh and S. Mohanta. 2018. Studies on set production of onion (Allium cepa L.) cultivars. *J. Allium Res*. **1(1):**28-31.

Mohamed, R. G., M. M. A. Abdalla., M. H. Z. El-Dekashey and S. Y. Attallah. 2012. Yield and quality of onion sets as affected by seeding rate and planting date under Assuit conditions. *Assiut J. Agric. Sci*. **43(1):**27-47.

Mohammedali, A. A., E. E. E. Elshukry., A. M. Alamin and A. Z. Elhag. 2022. Effects of seed bed, cultivars and seed rates on yield and quality of onion sets (*Allium cepa* L.). *J. Agron. Res*. **4(4):**9-16.

Motallebi, A., S. Masshia and F. Shekari. 2001. Effect of different sowing methods on yield and bulb characteristics in onion (*Allium cepa* L.). *Acta Agronomica Hungarica*. **49(2):**169-174.

NHB (National Horticulture Board). 2019. Indian Horticulture Database. National Horticulture Board, Ministry of Agriculture, Government of India, New Delhi.

Shock, C. C., E. B. G. Feibert and L. D. Saunders. 2004. Plant population and nitrogen fertilization for subsurface drip irrigated onion. *Hort Sci.* **39**:1722-1727.

Shock, C. C., E. B. G. Feibert., A. Riveira and L. D. Saunders. 2015. Response of onion yield, grade and financial return to plant population and irrigation system. Amer. Soc. *Hort Sci.* **45(9):**1312-1318.

Walle, T., N. Dechassa and W. T. Kebede. 2018. Yield and yield components of onion cultivars as influenced by population density at Bir Sheleko, North-Western Ethiopia. Academic Res. *J. Agril. Sci. and Res*. **6(3):**172-192.