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Comparative performance of onion genotypes using 'sets and seedlings' as planting material at Leh cold desert

Jagdish Singh Arya*[1], Narendra Singh[1], Preeti Singh Arya[2] and Anil Kant[3]

Defence Institute of High Altitude Research, Defence Research & Development Organization, C/o 56 APO, Leh-Ladakh (Jammu & Kashmir) India-194 101. [2]Department of Biochemistry, NDUA&T, Kumar Ganj Faizabad (Uttar Pradesh) India-224229. [3]Division of Biotechnology &Bioinformatics, JUIT, Waknaghat, Solan,(H.P.)-India.
**E-mail- Jagdishsingh0482@gmail.com*

Abstract

The present investigation was carried out to study the effect of two different planting materials (set and seedling) and genotypes on bulb yield, its quality and vegetative growth. The experimental material comprised of two planting material and ten genotypes. The experiments were conducted at High Altitude Research, Defence Research and Development Organization, Leh during 2013 and 2014 in Randomized Block Design with five replications. There was significant effect of type of planting material and genotypes on all the studied parameters. Wall Brown genotype showed highest plant survival, chlorophyll content, days to maturity, polar diameter, equatorial diameter, average bulb weight and bulb yield when grown through set among all the genotypes. The highest plant height and number of leaves, leaf area, were obtained in the genotype Brown Spanish. The highest TSS and dry matter were observed in the genotype Red Cereole. The lowest double/deformed bulbs and neck thickness was observed in the genotypes Lock Roy and Red Cereole. The results indicated that all the genotypes under set planting performed better than seedling ones.

Key words: *Allium cepa* L., seedling, set, cold desert, trans-Himalaya

Introduction

Onion (*Allium cepa* L.) is one of the earliest known spices and vegetable crops grown in temperate (Brewster, 1990), sub-tropical (Corgan and Kedar, 1990) and tropical climate (Currah and Proctor, 1990) throughout the world. This crop belongs to the family Alliaceae and is cultivated all the year round but in maximum area during Rabi season in India. The cultivation of onion *(Allium cepa* L) is accomplished by different methods like seed to bulb, seed to seedling to bulb and sets to bulb production. Brewster (1994) described sets as small onion bulbs, ranging from 2 to 3 g in fresh weight. They are produced by growing a crop from seed sown at a high population density of 1000 to 2000 plants per m^2. Sets less than 25 mm in diameter are planted to develop into larger bulbs. Owing to their size, sets produce a more robust plant at emergence as compared to seeds. This allows them to be grown successfully in less favorable growing conditions where the use of transplant and direct sowing are limited. Sets are commercially used to produce early green onions, but they can also be used for dry bulb production. While, growing onion from larger sets tend to produce higher yield it is also true that they mature earlier than those produced from smaller sized sets. On the other hand, they often produce splits and doubles and also are more likely to bolt (Suh and Kim, 1996; Brewster, 1994). Sets have a shorter growing season than plants from seeds and this advantage is often exploited when a rapid or early season production is required. In fact, it is possible to advance the crop by some 3 weeks when sets are used to raise a crop as compared to direct sowing (O'connor, 1994). The use of sets in onion production is particularly useful for extending the availability of the onions throughout the season. In Norway, large sets (up to 20 mm in diameter) are used to produce early bulb. Sets that are less than 16 mm in diameter rarely flower. The use of sets for producing an early crop of onion has been very popular among farmers in the East and the South East.

Ladakh is the highest altitude plateau region in India (much of it being over 3000 m) and is recognized as a *land of high passes.* It is the fraction of the tough terrains of trans- Himalayan region of India. The enormous mass of the Himalayas makes it a high altitude cold desert with diverse geographical and climatic conditions and altogether offer a tough life with scarce resources. Fragile ecological system and short cropping season (May to September) creates a big challenge to the agriculturists (Arya *et al.*, 2015). To grow any crop in this limited period, specific cultural practices are of utmost importance. Most of the research works in India, pertaining to development of suitable agro-techniques for quality onion production have been carried out in the physiographic conditions of plains and lower hilly regions. Not much research work has been carried out on onion production in the high altitude cold desert physiographic conditions. Therefore, the problems of onion shortage can be overcome upto certain extent by boosting onion production and quality by using sets. With this aim, the study was carried out on onion production through sets and seedlings as a planting material in this region. The sets use the stored food to develop their roots inside the soil, however; seedlings synthesize their food by photosynthesis in green leaves and nutrients absorbed by the small and soft roots. But the green leaves do not remain alive at low temperature during early planting in March- April and crop fail to grow through seedlings. With the above mention advantages, the sets can be planted about 60 days early than the seedlings and it increases cropping period of the crop (Singh *et al.*, 2015). Due to lack of knowledge, the local farmers are growing short day cultivars.

The cultivars of this group give low yield with poor quality of the bulbs in long day conditions of this region. The bulbs of these varieties split during its formation and can be divided easily in 3-5 parts after harvest. After separation, the bulbs remain small in size and poor in shape. These types of bulbs are not suitable in the specifications of Army, hence maximum produce are rejected and local supply of onion to the army remains low (Singh *et al.*, 2015). The information on the effect of genotypes and planting material on yield and quality of onion bulb is not available in respect of bulb production in Ladakh conditions. Therefore, the present study was conducted to observe performance of genotypes using different planting material on yield and quality of onion bulbs at trans-Himalaya Ladakh, India.

Materials and methods

The experiment was conducted during the month of May to October in 2013 and 2014 in the Vegetable Research Unit at the Defence Institute of High Altitude Research, Leh-Ladakh, (altitude 3500 m above MSL, latitude 34°8'16.119" N, longitude 77°34'19.2216"E). The soil texture of the experimental site was silty loam with pH 7.1±0.2. Organic carbon and organic matter content were 1.2±0.4 and 4.2±0.5 %, respectively.

The experimental material consisted of 10 genotypes of onion *viz*. Red Cereole, Katarina Red 3, Katarina Red 7, Supreme, Cyrus, Lock Roy, Legend, Wall Brown, Brown Spanish and a Local Cultivar having broad spectrum of variation which was received from Bejo Sheetal Seeds. The experiment was laid down in randomized block design (RBD) with five replications. The plot size for each treatment was 2×1 m. Sets and seedlings of all the genotypes selected were of uniform size based on visual observations and transplanted on flat bed system. The seedlings of particular density were transplanted on flat beds in their respective plots with constant 20 cm intra-row distance, while the in-row spacing was 10 cm. Well rotten farmyard manure (FYM) at the rate of 20 t ha^{-1} was incorporated to the soil 30 days before planting the seedlings. The recommended dose of NPK fertilizes was applied at a ratio of 80- 60-60 kg ha^{-1}. All the phosphorous, potash and half dose of nitrogen was applied during transplanting the seedlings while the remaining half dose of nitrogen was applied after 30 days. All the cultural and management practices *viz*. irrigation, weeding, hoeing and sprays for insect pests and disease control etc. were carried out uniformly for all treatments. Observations were recorded from 10 randomly selected plants from each genotype in each replication for fourteen traits *viz*., plant survival (%), plant height (cm), number of leaves per plant, leaf area (cm^2), chlorophyll content (cci), neck thickness (cm), total soluble solids (%), dry matter (%), polar diameter (cm), equatorial diameter (cm), bulb shape index, average bulb weight (g) and bulb yield (kg/plot). Data recorded over 2 years were pooled due to a non-significant heterogeneity test (Azmat *et al.*, 2011). Means of all observations were calculated for quantitative traits and subjected to SPSS 21 statistical software. Two-way ANOVA with 2-sided Tukey's HSD at $P \leq 0.05$ was carried out.

Results and discussion

When planted through seedlings and sets, the plants arising from sets were highly superior to the plants raised from seedlings (Table 1). Amongst the genotypes, maximum survival rate was observed for Wall Brown (64.20 %) followed by Supreme (61.70 %) and Katarina Red 7(61.45 %) while in those raised from the sets, the highest survival rate was observed for Wall Brown (98.15 %) followed by Lock Roy (98.00 %) and Supreme (97.65 %). The perusal of data (Table 1) indicated that the plant height in all the genotypes was significantly higher in the plants that were raised from the sets than those raised from the seedlings. Among all the plants raised from seedlings (Table 1), maximum plant height was observed for Brown Spanish (42.74 cm) followed by Red Cereole (38.46) and Supreme (37.29 cm) whereas in those raised from the sets, the maximum plant height was recorded for Brown Spanish (48.28 cm) followed by Red Cereole (41.12 cm) and Cyrus (39.61 cm). The plants raised from the sets showed significantly higher number of leaves than those raised from the seedlings for all the genotypes. Among plants raised from seedlings maximum number of leaves was observed for Brown Spanish (13.87) followed by Local Cultivar (11.02) and Supreme (9.25). The plants grown through sets showed the maximum number of leaves for the genotype Brown Spanish (16.02) followed by Local Cultivar (11.74) and Supreme (9.56).

The data pertaining to the leaf area depicted that plants raised from the sets had significantly higher leaf area compared to those

Table 1. Effect of set and seedling planting on plant survival, plant height and number of leaves of onion bulb at agro climatic condition of Leh

Lines	Plant survival (%)		Plant height (cm)		Number of leaves	
	Seedling	Set	Seedling	Set	Seedling	Set
Red Cereole	57.70±4.35^{abc}	97.55±1.92^{d}	38.46±2.76^{cd}	41.12±2.64^{bc}	8.52±1.42^{cd}	9.30±1.16^{b}
Katarina Red 3	56.25±7.65^{abc}	93.80±3.72^{d}	29.75±3.50^{ab}	31.04±3.62^{a}	4.92±0.88^{a}	5.15±0.53^{a}
Katarina Red 7	61.45±3.85^{cd}	97.60±1.19^{b}	33.58±3.03^{abc}	35.55±2.57^{ab}	6.24±0.66a^{bc}	6.28±0.94^{b}
Supreme	61.70±2.39^{cd}	97.65±1.93^{b}	37.29±2.01^{bcd}	38.95±1.10^{ab}	9.25±0.78^{de}	9.56±0.65^{bc}
Cyrus	52.30±3.91^{b}	92.25±2.63^{a}	36.65±4.38^{abcd}	39.61±4.71^{ab}	8.22±1.62b^{cd}	9.06±0.78^{b}
Lock Roy	60.75±3.54^{cd}	98.00±1.13^{b}	32.18±1.93^{abc}	34.44±1.26^{ab}	7.06±0.71^{abcd}	7.39±0.67^{ab}
Legend	54.60±2.97^{c}	97.30±2.68^{b}	32.18±1.34^{abc}	34.28±1.02^{ab}	8.28±2.06^{cd}	9.35±2.55^{c}
Wall Brown	64.20±1.92^{d}	98.15±1.27^{b}	33.27±4.31^{abc}	35.39±5.28^{ab}	5.84±0.59^{ab}	6.23±0.90^{a}
Brown Spanish	50.90±3.31^{b}	94.80±2.27^{a}	42.74±5.53^{d}	48.28±8.55^{c}	13.87±1.06^{f}	16.02±0.98^{d}
Local Cultivar	61.35±3.73^{cd}	94.45±3.21^{ab}	28.93±5.21^{a}	34.11±3.40^{ab}	11.02±0.85^{e}	11.74±1.00^{c}
Mean	58.11±5.63	96.16±2.94	34.50±5.25	37.28±5.97	8.32±2.74	9.01±3.20

Values represented as mean ± SD; for each column, different lowercase letters indicate significantly different at $P<0.05$, as measured by 2-sided Tukey's HSD among genotypes. Value (Mean± SE) bearing common superscript within column does not differ significantly.

raised from the seedlings for all the genotypes (Table 2). Among the plants raised from seedlings, maximum leaf area was observed for Brown Spanish (129.89 cm^2) followed by Wall Brown (56.51 cm^2) and Cyrus (52.92 cm^2) while in those raised from the sets the maximum leaf area was observed for Brown Spanish (157.07 cm^2) followed by Wall Brown (65.53 cm^2) and Cyrus (61.26 cm^2). The observation of data (Table 2) revealed that among all the genotypes, maximum chlorophyll content was recorded for the genotype Wall Brown (39.86 cci) followed by Red Cereole (39.63 cci) and Cyrus (37.80 cci) when grown through seedling while in those raised from the sets the maximum chlorophyll content was recorded for Wall Brown (39.88 cci) followed by Red Cereole (39.79 cci) and Cyrus (43.27 cci). The days to maturity was found to be significantly lower in the plants raised from the sets compared to those raised from the seedlings for all the genotypes (Table 2). The difference was highly significant.

Maximum days to maturity was observed for Wall brown (178.10) followed by Cyrus (177.20) and Brown Spanish (176.70) for plants raised from seedlings whereas in those raised from the sets, maximum days to maturity was observed for Wall Brown (137.60) followed by Cyrus (135.75) and Brown Spanish (135.70).

Occurrence of double/deformed bulbs in various genotypes was found to be non-significantly different from each other (Table 3). Minimum double/deformed bulbs were observed for Lock Roy (0.74 %) followed by Cyrus (0.86 %) and Supreme (1.13 %) for plants raised from seedlings. On the other hand, the plants that were raised from the sets, showed minimum double/deformed bulbs in the genotype Lock Roy (0.82) followed by Cyrus (0.84 %) and Supreme (1.26 %).

Minimum neck thickness was observed for the Red Creole (0.64 cm) followed by Wall Brown (0.71 cm) and Katarina Red 7 (0.77 cm) while among all the genotypes that were raised from the sets, minimum neck thickness was observed for Red Creole (0.61 cm) followed by Wall Brown (0.69 cm) and Katarina Red 7 (0.71). In both the types, the difference was non-significant (Table 3).

In case of the plants grown through the seedling, highest total soluble solid was observed for the Red Cereole (13.14 %) followed by Katarina Red 3 (12.53 %) and Katarina Red 7 (11.92 %). while in those raised from the sets it was highest for

Table 2. Effect of set and seedling planting on leaf area, chlorophyll content and days to maturity of onion bulb at agro climatic condition of Leh

Lines	Leaf area (cm^2)		Chlorophyll content (cci)		Days to maturity	
	Seedling	Set	Seedling	Set	Seedling	Set
Red cereole	47.94±9.03^{a}	65.48±9.39^{b}	39.63±2.11^{ab}	39.79±0.54^{bc}	169.10±1.08^{a}	131.50±1.06^{b}
Katarina Red 3	23.33±7.49^{a}	27.10±8.35^{a}	33.24±1.41^{a}	33.77±0.89^{a}	169.20±1.92^{a}	131.90±1.08^{b}
Katarina Red 7	41.91±7.80^{b}	49.61±7.71^{cd}	32.43±0.93^{a}	32.24±0.98^{a}	171.40±1.34^{b}	133.10±1.29^{a}
Supreme	46.79±6.53^{ab}	59.32±6.21^{ab}	35.24±2.25^{ab}	39.30±3.96^{bc}	173.80±1.10^{b}	134.40±1.02^{a}
Cyrus	52.94±8.79^{ab}	61.26±7.28^{ab}	37.80±5.82^{ab}	43.27±2.69^{c}	177.20±1.30^{c}	135.75±1.46^{ab}
Lock Roy	35.09±8.43^{ab}	40.60±11.11^{ab}	34.31±2.30^{a}	36.70±3.37^{ab}	172.40±0.82^{c}	135.10±0.82^{b}
Legend	38.86±10.98^{ab}	43.93±7.00^{abc}	36.60±2.27^{ab}	37.75±2.40^{ab}	177.00±1.00^{c}	135.70±11.39^{b}
Wall Brown	56.51±30.71^{b}	65.53±10.04^{b}	39.86±2.04^{b}	39.88±2.35^{bc}	178.10±0.55^{c}	137.60±0.82^{ab}
Brown Spanish	129.89±17.17^{c}	157.07±23.57^{d}	36.39±1.88^{a}	40.24±4.27^{bc}	176.70±0.57^{c}	135.70±0.82^{ab}
Local Cultivar	35.04±5.09^{ab}	42.80±5.15^{ab}	34.84±1.52^{ab}	35.76±1.50^{ab}	172.80±1.35^{b}	132.40±0.42^{a}
Mean	50.83±31.02	61.22±37.68	35.66±3.13	37.82±3.93	173.77±3.37	134.96±4.64

Values represented as mean ± SD; for each column, different lowercase letters indicate significantly different at $P<0.05$, as measured by 2-sided Tukey's HSD among genotypes. Value (Mean± SE) bearing common superscript within column does not differ significantly.

Table 3. Effect of set and seedling planting on double/deform bulb, neck thickness and total soluble solids of onion bulb at agro climatic condition of Leh

Lines	Double /deform bulb (%)		Neck thickness (cm)		Total soluble solids	
	Seedling	Set	Seedling	Set	Seedling	Set
Red cereole	4.77±0.44^{b}	5.32±0.84^{b}	0.64±0.08^{a}	0.61±0.06^{a}	13.14±0.85^{d}	13.90±0.58^{d}
Katarina Red 3	4.41±0.49^{b}	4.88±0.30^{b}	1.00±0.07^{a}	1.01±0.08^{b}	12.53±0.93^{cd}	13.69±0.42^{d}
Katarina Red 7	1.96±1.27^{a}	2.26±0.91^{a}	0.77±0.06^{a}	0.71±0.04^{ab}	11.92±1.31^{cd}	13.28±1.18^{d}
Supreme	1.13±0.72^{a}	1.26±0.56^{a}	0.81±0.14^{a}	0.72±0.14^{ab}	8.29±0.37^{b}	9.19±0.41^{b}
Cyrus	0.86±0.30^{a}	0.84±0.32^{a}	0.90±0.27^{a}	0.78±0.25^{ab}	6.55±0.45^{ab}	7.16±0.57^{a}
Lock Roy	0.74±0.30^{a}	0.82±0.20^{a}	0.98±0.15^{a}	0.79±0.13^{ab}	7.44±0.92^{ab}	7.83±0.78^{ab}
Legend	1.34±0.52^{a}	1.60±0.63^{a}	0.96±0.12^{a}	0.93±0.13^{ab}	6.38±0.81^{ab}	7.14±0.80^{a}
Wall Brown	8.43±1.52^{c}	10.15±1.53^{c}	0.71±0.04^{a}	0.69±0.05^{ab}	6.48±0.44^{a}	6.90±0.42^{a}
Brown Spanish	11.21±1.19^{d}	13.18±1.95^{d}	2.56±0.37^{b}	2.37±0.27^{c}	10.93±0.48^{c}	11.33±0.46^{c}
Local Cultivar	98.90±1.14^{e}	99.44±0.47^{e}	3.06±0.68^{b}	3.16±0.29^{d}	6.90±1.07^{ab}	7.62±1.15^{a}
Mean	13.38±29.01	13.98±29.07	1.24±0.85	1.18±0.84	9.09±2.71	9.79±2.90

Values represented as mean ± SD; for each column, different lowercase letters indicate significantly different at $P<0.05$, as measured by 2-sided Tukey's HSD among genotypes. Value (Mean± SE) bearing common superscript within column does not differ significantly.

Table 4. Effect of set and seedling planting on dry matter, polar diameter and equatorial diameter of onion bulb at agro climatic condition of Leh

Lines	Dry matter (%)		Polar diameter (cm)		Equatorial diameter (cm)	
	Seedling	Set	Seedling	Set	Seedling	Set
Red cereole	14.71±0.76^{d}	15.50±0.72^{d}	4.80±0.68^{b}	5.03±0.53^{a}	6.12±0.31^{bc}	6.55±0.41^{bcd}
Katarina Red 3	14.18±0.82^{cd}	15.35±0.35^{d}	4.65±0.43^{ab}	4.78±0.40^{ab}	4.14±0.80^{ab}	4.55±0.49^{ab}
Katarina Red 7	13.59±1.22^{cd}	14.89±1.08^{d}	5.64±1.15^{bcd}	5.98±0.88^{bc}	5.02±0.31^{bc}	5.14±0.24^{abc}
Supreme	9.87±0.55^{b}	10.82±0.45^{b}	5.86±0.50^{bcd}	5.84±0.63^{bc}	6.21±0.33^{bc}	6.45±0.60^{cd}
Cyrus	8.20±0.20^{a}	8.83±0.51^{a}	6.62±0.99^{cd}	6.01±1.3^{b}	6.13±1.22^{c}	7.35±1.46^{d}
Lock Roy	9.09±0.75^{ab}	9.47±0.64^{ab}	5.47±0.55^{b}	5.80±0.49^{c}	6.59±0.87^{c}	6.91±0.62^{cd}
Legend	8.19±0.79^{ab}	8.48±1.04^{a}	6.74±0.74^{cd}	6.84±0.73^{c}	6.53±1.61^{c}	7.63±1.37^{d}
Wall Brown	8.21±0.38^{ab}	8.55±0.34^{a}	7.01±0.75^{d}	7.28±0.97^{c}	9.60±1.15^{d}	9.96±0.73^{c}
Brown Spanish	12.60±0.18^{c}	12.93±0.38^{c}	6.00±0.32^{bcd}	6.21±0.31^{bc}	5.78±0.81b^{c}	5.93±1.11^{bcd}
Local Cultivar	8.50±1.31^{ab}	9.37±1.03^{ab}	3.66±0.51^{a}	4.04±0.50^{a}	3.58±0.55^{a}	3.82±0.44^{a}
Mean	10.73±2.69	11.43±2.89	5.64±1.19	5.75±1.10	6.32±1.78	6.39±1.83

Values represented as mean ± SD; for each column, different lowercase letters indicate significantly different at $P<0.05$, as measured by 2-sided Tukey's HSD among genotypes. Value (Mean± SE) bearing common superscript within column does not differ significantly.

Red Cereole (13.90 %) followed by Katarina Red 3 (13.69 %) and Katarina Red 7 (13.28). However, the variation was non-significant in both the cases (Table 3).

Highest dry matter content was observed for Red Cereole (14.71 %) followed by Katarina Red 3 (14.18 %) and Katarina Red 7 (13.59 %) in those which were grown through seedling (Table 4). While in those raised from the sets, significantly high dry matter content was observed for Red Cereole (15.50 %) followed by Katarina Red 3 (15.35 %) and Katarina Red 7 (14.89 %). There was a non-significant variation for dry matter content of bulbs between those grown from seedlings or sets.

Among all the genotypes, significantly higher polar diameter was observed for Wall Brown (7.01 cm) followed by Legend (6.74 cm) and Cyrus (6.62 cm) when grown through seedlings (table 4). In those raised from the sets, significantly higher polar diameter was observed for Wall Brown (7.28 cm) followed by Legend (6.84 cm) and Cyrus (6.01 cm). The plants raised from sets registered significantly higher polar diameter than those raised from the seedlings.

The plants raised from sets were observed to record significant maximum equatorial diameter than those raised from the seedlings (Table 4). Maximum equatorial diameter was observed for the Wall Brown (9.60 cm) followed by Legend (6.53 cm) and Cyrus (6.13 cm) in the bulbs raised from seedlings, while in those raised from sets significant maximum equatorial diameter was observed for Wall Brown (9.96 cm) followed by Legend (7.63 cm) and Cyrus (7.35 cm). When planted from seedlings and sets, the plant arising from sets were highly superior to the plants raised from seedlings.

Amongst the genotypes, maximum average bulb weight was observed for Wall Brown (152.61g) followed by Legend (138.36 g) and Cyrus (138.34 g). Whereas those raised from the sets the highest average bulb weight was observed for Wall Brown (203.08 g) followed by Legend (194.12 g) and Cyrus (185.04 g) (Table 5).

Table 5. Effect of set and seedling planting on average bulb weight and yield of onion bulb at agro climatic condition of Leh

Lines	Average bulb weight (g)		Bulb yield (kg/ plot)	
	Seedling	Set	Seedling	Set
Red Cereole	100.56±5.48^{abc}	107.37±9.30^{a}	11.62±1.22^{bc}	20.95±1.99^{a}
Katarina Red 3	81.73±7.28^{b}	91.37±5.51^{a}	9.20±1.44^{cd}	17.14±1.25^{a}
Katarina Red 7	92.89±6.94^{b}	107.32±6.76^{a}	11.40±1.28^{c}	20.94±1.21^{ab}
Supreme	114.63±17.88^{cd}	145.51±16.30^{b}	14.15±2.35^{c}	28.42±3.16^{c}
Cyrus	138.34±12.86^{ef}	185.04±11.24^{c}	14.47±1.16^{c}	34.15±1.23^{d}
Lock Roy	103.11±13.17^{bc}	145.57±13.59^{a}	12.56±1.93^{b}	28.51±2.40^{c}
Legend	138.36±4.29^{de}	194.12±10.12^{c}	15.10±0.60^{b}	37.77±2.24^{d}
Wall Brown	152.61±5.68^{f}	203.09±5.19^{c}	19.59±0.85^{c}	39.86±2.42^{d}
Brown Spanish	103.28±10.77^{c}	132.94±12.40^{b}	10.55±1.68^{ab}	25.22±2.52^{bc}
Local Cultivar	80.75±9.47^{a}	88.59±9.13^{a}	9.17±1.01^{ab}	16.73±1.81^{a}
Mean	109.53±24.55	140.09±41.74	12.73±3.17	26.96±8.09

Values represented as mean ± SD; for each column, different lowercase letters indicate significantly different at $P<0.05$, as measured by 2-sided Tukey's HSD among genotypes. Value (Mean± SE) bearing common superscript within column does not differ significantly.

In all the genotypes the bulb yield was found to be significantly higher in the plants raised from the sets than those raised from the seedling (Table 5). Among plants raised from seedlings, maximum bulb yield was observed for Wall Brown (19.59 kg/ plot) followed by Legend (15.10 kg/plot) and Cyrus (14.47). Whereas those raised from sets the maximum bulb yield was observed for Wall Brown (39.86 kg/plot) followed by Legend (37.77 kg/plot) and Cyrus (34.15 kg/plot). The plants raised from sets were observed to give highly significant maximum bulb yield than those raised from the seedlings.

The difference between the genotypes included in this study might be due to the differences in their genetic makeup as has been reported by Kandil *et al.* (2010). Similar results were obtained by Akhtar (2002) and Gemma *et al.* (2007). Soleymani and Shahrajabian (2012) reported that foliage fresh weight, bulbing ratio, plant height, weight of bulb, total yield, total percentage of dry matter and nitrate content in bulb was significantly influenced by genotype. The stimulatory effect

of sets on all the quantitative and qualitative traits could have been due to presence of more sprouting initials and reserved food material thereby resulting in better establishment and survival of plants. Similar finding was reported by Khodadadi (2012) and Islam (2002). Pakyurek *et al.* (1994) tested various varieties for yield and quality and concluded that not all the varieties gave similar response. Similarly, Rumpel and Felezynski (1997) reported that greater yield was produced by Mercato and lower yield was obtained in Summit. Onion production is significantly influenced by cultivars and agronomic practices (Mondal *et al.,* 1986; Mondal, 1991). A cultivar performs differently under different agroclimatic conditions and various cultivars of the same species grown even in the same environment often yield differently. The sets can withstand severe cold conditions without damage as it remains 4-5 cm inside the soil after planting and during this period, it uses the stored food stuff to develop their roots. However, the green seedlings tends to get damaged due to severe cold because the seedlings synthesize their food by photosynthesis in green leaves and when the nutrients are absorbed by the small and soft roots. But these green leaves do not remain alive at such low temperature during early planting in March-April and so it causes failure of crop growth through seedlings (Singh *et al.*, 2015).

The result showed that the set plays an important role in potential growth performance by influencing all the qualitative and quantitative traits in all genotypes as compared to the seedling. Amongst the genotypes Wall Brown followed by Legend and Cyrus gave highest bulb yield raised through sets. Therefore, the above three genotypes may be recommended for the cultivation through sets for high bulb yield at district Leh.

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