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Impact of N-fertilization on Onion Bulb Production of Different Genotypes through Onion-Set

Israr Ullah Khan[1], Muhammad Saleem Jilani[1], Muhammad Amjad Nadeem[2], Mehwish Kiran[2], Tehseen Ali Jilani[3] and Husnain Saleem[4]

[1]Department of Horticulture, Faculty of Agriculture, Gomal University, Dera Ismail Khan, Pakistan.
[2]Department of Agronomy, Faculty of Agriculture, Gomal University, Dera Ismail Khan, Pakistan.
[3]Department of Horticulture, Faculty of Agricultural Sciences, Ghazi University, Dera Ghazi Khan, Pakistan.
[4]Faculty of Agriculture, Gomal University, Dera Ismail Khan, Pakistan.

(Corresponding author: Tehseen Ali Jilani)
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ABSTRACT: Onion (*Allium cepa* L.) belongs to Amarylidaceae (Amaryllis) or Liliaceac family and is an important one amongst world's best vegetables. Usually, onion cultivation is accomplished by different methods like seed to bulb, seed to seedling and then bulb, onion set to green onion bulbs etc. Sets are small and dry onion bulbs, which generally mature about a month earlier and produce more yield than seeded onions. Sets are commercially used to produce early green onions and fill the market gap. In this research study, the research trial was carried out to assess impact of multiple nitrogen doses on onion bulb production of different genotypes through onion-set at Nursery Farm, Faculty of Agriculture, Gomal University, D.I. Khan, during 2019. RCBD was set in split plot layout to carry out the trial. Each sub-plot size was maintained at 6 m^2, where the experiment was divided into three replicates. Varieties were sown in main plots while N-levels were designated as sub-plot treatments. Different parameters were studied including survival percentage, days to 50% sprouting, leaf length (cm), leaves' count ($bulb^{-1}$), bulb diameter (cm), shoots ($plant^{-1}$), bulb weight (kg), number of split bulbs ($plant^{-1}$), bulb neck ratio leaf and bulb yield (t ha^{-1}). Among various interactions between factors, onion variety Shah Alam supplied with 180 kg N ha^{-1} had highest survival percentage (96.75), earliest 50% sprouting (24 days), leaf length (81.56 cm), leaves per bulb (51.84), bulb dia (3.76 cm), shoots (7.22 plant-1), bulb neck ratio leaf (3.99) and bulb yield (24.95 t ha^{-1}). Thus, it was concluded that 180 kg N ha^{-1} may be incorporated into the soil using onion variety Shah Alam to enhance bulb production; therefore, it was recommended for general production in D.I. Khan region.

Keywords: Onion, N-Fertilization, Onion Bulb Production, Onion Set

I. INTRODUCTION

Onion (*Allium cepa* L.) belongs to Amarylidaceae (Amaryllis) or Liliaceac family and is an important one amongst world's best vegetables. It is monocotyledonous, monoeceous and cross-pollinated cool season crop. It has high mineral and organic contents, which are essential for human health. Onion is common ingredient used in multiple recipes because of its distinctive flavor. It is commonly used for manufacturing soaps, meat dishes, salads, sandwiches as well as cooked alone as a vegetable. Mature onion bulb contains starch, appreciable qualities of sugar, some protein and vitamins A, B and C. Commercial cultivation of onion holds about 320 (000) hectares with 2 million tonnes total gain, showing an average of 12-13 tonnes per hectare. Onion is successfully grown in major districts of all provinces of Pakistan.

Origin of onion plant is defined as Central Asia by several botanists, archaeologists and food historians. It was also suggested that onion was first sown in Iran and West Pakistan. The use of onion in very early age or long before farming is also presumed. Onion is probably originated in Afghanistan, Russian states, Western Asia and around Mediterranean Sea.

Growing of onion through sets in not very common practice in Pakistan. Usually, onion cultivation is accomplished by different methods like seed to bulb, seed to seedling and then bulb, onion set to green onion bulbs etc. Sets are small and dry onion bulbs, which generally mature about a month earlier and produce more yield than seeded onions. Sets are commercially used to produce early green onions. High yield and early maturity is recorded by using larger size sets, but split and bolting in doubles is also shown with large sets. Smaller sets (less than 1.25 cm in diameter) are mostly used for producing dry onion bulbs, while larger sets (greater than 1.87 cm in diameter) are considered suitable for production of green onions. There are different types of onion are grown in Pakistan. There are different cultivars pertaining to multiple localities are successfully grown in the country. Generally, onion is distributed on the basis of color, aroma, small, medium and large size for storage purpose. Reddish types of onion are more acidulous and bitter, while white types have longer shelf life. It is evident that in Pakistan, availability of onion is mostly seasonal dependent. The prices are at bottom in production days, while the people face shortage of crop, as well as high prices during off-season time.

The situation might be due to less productivity of varieties, whereas increased population is also another issue in the country. Likewise, improper and inadequate application of fertilizers to unsuitable varieties is also resulted in lower production. It is obvious that a suitable variety should be sown in a locality supported by optimum fertilizer application. Nitrogen is an important and necessary plant food nutrient. Khan *et al.,* (2007) [1] attained highest bulb production with N at 100 kg ha-1, while best results were achieved by using N:150, P:100, K:50 kg ha^{-1} [2]. Also observed highest bulb yield of onion cv. Shah Alam by using N@120 kg ha^{-1} [3]. Nitrogen is essential element for enhancing bulb size and yield, but excessive use of N causes delayed bulb maturity [4].

Like other crops, production of onion is greatly affected with environmental aspects, varieties as well as agronomic practices including size of onion sets, spacing, and N-fertilization etc. For obtaining earlier crop in the market during crisis period, onion should be planted through onion set to bulbs. In this method, the crop matures about 3-4 weeks earlier, but it costs comparatively higher. Considering the aforementioned facts, this experiment was designed to test different onion varieties for bulb production through onion sets and multiple rates of nitrogen.

Objectives

i) Screening of different genotypes for bulb production through onion set.

ii) To check suitable N-level for better bulb yield through onion set.

II. LITRATURE REVIEW

Assefa *et al.,* (2016) depicted that incorporation of multiple doses of NP showed non-significant influence on height, bulb weight, marketable & total production. The use of 132:240 kg/ha NP produced maximum bulb weight (90.5 g), which was followed by 87.5 g bulb weight obtained by using 92:240 kg NP/ha. Highest marketable yield (23 t/ha) was recorded in 92:160 kg NP/ha treatment. It was followed by 22.6 t/ha yield recorded with 92:220 kg NP/ha. Similarly, maximum total bulb yield (23.45 t/ha) was obtained by using 92:160 kg NP/ha. The recommended the said treatment combination for getting higher yield in similar ecological areas [5].

Gebretsadik & Dechassa (2016) observed significant impact of N-levels and intra-row space in fresh bulb weight & diameter, marketable/total yield. They found 100 kg N/ha as the best dosage on nitrogen because this treatment gave optimum marketable (31.46 t/ha) and total bulb yield (32.84 t/ha), bulb weight (86.50 g). They concluded that combination of 6 × 20 cm spacing with 100 kg N/ha might be the most suitable treatment for onion cultivar Bombay Red [6].

Messele, (2016) tested nitrogen and phosphorus for increasing onion production. Results showed that N-application significantly affected onion production, while phosphorus application as well as interaction didn't show significant impact. Height of plants (10.46%), number (8.59%) and length (5.82%) of leaves become increased over control by using nitrogen (50 kg/ha). However, diameter of leaves and length of bulbs showed non-significant behavior. The study further revealed non-significant impact for plant tallness, quantity and length of leaves by sole application of P and also the interaction between N and P [7].

Gebremichael *et al.,* (2017) stated that onion is an important crop both as a condiment and income generation for smallholder farmers in north western Zone of Tigray. However, continuous use of inorganic fertilizers and inappropriate soil fertility management practices are among the major factors limiting onion productivity in the region. They revealed in an experiment that combined application of 5 t ha^{-1} VC+50% inorganic N fertilizers recorded the highest plant height (71.67 cm), leaf number (16.15), leaf length (45.19 cm), neck thickness (1.51 cm), bulb length (5.51 cm), bulb diameter (5.90 cm), mean bulb weight (92.64 g), biological yield (131.42 g), harvest index (82.18%), marketable yield (35.13 t ha^{-1}), bulb dry weight (35.46%), total dry biomass (40.27 g), and total yield (35.25 t ha^{-1}). It could, thus, be concluded that, based on the partial budget analysis and result of soli analysis after harvest the application of 5 t ha^{-1} vermicompost and 50 % recommended inorganic nitrogen was the appropriate combination for better onion production with minimum weight loss in the study area [8].

Ghoname *et al.,* (2017) recorded improvement in fresh bulb weight, neck diameter, bulb length and width, bulb N content (%), when N-application was delayed with short IWP (7 days), but late addition of N caused reduction in dry matter (%) and TSS (%). Late application of nitrogen in combination with short IWP enhanced almost all yield related traits, but bulb storability was inversely affected because of more total bulb loss either as total weight loss (%) or deteriorated weight loss (% sprouted/rotten bulbs). The reported normal N-application with moderate IWP (14 days) as best treatment, which resulted in satisfactory bulb characteristics with moderate yield [9].

Manna *et al.,* (2017) recorded significant results for plant height, flower stocks/plant, seed/umbel, TSW, seed yield, nutrient accumulation in seed, germination (%) by various treatments. Application of 175-120 kg NK/ha produced highest seed yield (9 q/ha), followed by 125-120, 175-100 and 175-80 kg NK/ha, respectively, which were significant with rest of the treatments. They concluded that using 80-120 kg K in addition to 175 kg N/ha could be more beneficial for increased flowering stalks and better quality onion with higher seed yield [10].

Nawaz *et al.,* (2017) obtained highest yield and yield related traits by using 150 and 125% of RFD in ridge sowing technique. However, they recorded higher economic returns with N-application at 125% RFD, using ridge planting as compared to other treatments. The recommended this treatment as most effective method regarding expenses incurred on onion production under salt affected soils [11].

Sekara *et al.,* (2017) observed the effects of increasing temperature in growth time of onion crop and found reduction in marketable yield. They showed that for storage of onion, nutritional requirements were at highest levels. The use of humic substances to mycorrhizae inoculated germplasm might have

enhanced growth and quality of bulbs under stress environments. Generally, onion is a slow growing plant with shallow roots and non-shading habit, therefore, the productivity is highly depending on availability of moisture in soil, adequate manuring supported by weed control. They reported being genetic character, onion shelf-life might be improved with efficient management of both, crop as well as post-harvest followed by proper storage facilities. Quality of stored bulbs may be attributed by multiple indicators including thiosulfonates, pyruvic acid, TSS, sugars and other biological compounds [12].

Singh *et al.,* (2017) reported that nitrogen application (N4 @ 140 kg/ha) was found most effective treatment for better growth and production of onion. Likewise, plant spacing S1 (15 × 10 cm) showed best results. Similarly, the interactive combination N3S1 (130 kg/ha with 15 × 10 cm) produced maximized results pertaining to onion growth and yield [13].

Wichrowska *et al.,* (2017) revealed that higher rates of nitrogen application caused reduction in bulb dry matter contents. The 'Kutnowska' showed a higher content of total sugar and, at the same time, a lower content of monosaccharide than 'Efekt'. 'Efekt' reacted with an increase in the content of vitamin C and monosaccharide as affected by higher fertilization rates. A different reaction was noted in 'Kutnowska'. The lower the dry matter content in onion bulbs – the greater content of total sugars and less content of monosaccharides [14].

Yayeh *et al.,* (2017) observed significant results of most growth and yield attributes with nitrogen, phosphorus, sulphur (NPS) fertilization. Using 105-122.6-22.6 kg NPS/ha produced significantly tallest plants (69.23 cm) and above ground biomass (25.33 g). Similarly, biggest bulbs (4.27 cm), leaves' count (13.4/ plant), marketable (17.42) and total bulb yield (17.8 t/ha) were given by 140-122.6-22.6 kg NPS/ha, which was statistically akin with 140-92-17 kg NPS/ha. However, NPS at 140-92-17 kg/ha showed maximum marginal return [15].

Abo-Dahab *et al.,* (2018) worked on nitrogen application (doses and methods). They reported that N-application (120 kg/Fed. with starter dose) showed significant variations in height, leaves/plant, bulb diameter, length and weight, time to maturity for two consecutive seasons. Nitrogen application as top dressing showed maximum values for vegetative parameters, whereas TSS (%) and dry matter (%) were also recorded at maximum levels. The said treatment also gave highest values of total and marketable yield during both the seasons. They suggested the application of nitrogen at 120 kg/Fed. along with starter dose using top dressing method for getting maximized onion production [16].

Bekele, (2018) reported most of the growth, quality and yield related traits showed significant behavior with multiple K-levels. During two-month storage at ambient storage temperature and humidity, application of higher dose of K (120 kg/ha) significantly decreased bulb rots (%), bulb sprouts (%), weight loss (%) and prolonged weeks to 50% bulb sprout [17].

Gateri *et al.,* (2018) showed that N application had significant effect on bulb splitting and neck thickness at harvest and adversely affected storage life through increased PLW and rotting and sprouting of bulbs. Time of application also significantly affected these parameters, with early application leading to increased PLW, rotting and late application splitting and sprouting of bulbs. The Red creole variety exhibited a better shelf-life compared to the Red Tropicana F1 hybrid. Nitrogen application is important for increased yields but excessive application beyond 52 kg N ha^{-1} should be avoided for bulbs intended for storage. Application time is increasingly important in enhancing quality of onion before and after storage [18].

Gebretsadik & Dechassa (2018) expressed significant observations pertaining to onion production using nitrogen and intra-row spacing. They recorded significant results regarding bolting (%), leaf length, bulb dia and commercial yield through Nfertilization and maintain intra-row space. They found that application of 100 kg/ha nitrogen 833,300 plant population resulted in maximum commercial (26.72 t/ha) yield, along with economic benefits. They concluded that onion variety "Bombay Red" could be sown by maintaining 6 × 20 cm intra-row space (833,300 plant) [19].

Gondane *et al.,* (2018) applied Sulphur to onion crop for its better quality and yield enhancement. They reported that using Sulphur (40 kg/ha) resulted in improved yield and related attributes. This treatment showed significantly lowest splitted bulbs and bolting (%) and time for maturity. However, bulb quality attributes viz. TSS, chlorophyll and oleoresin content were recorded as superior at 60 kg/ha sulphur [20].

Marrocos *et al.,* (2018) found that potassium fertilization enhanced K-contents in onion leaves, marketable and total bulb yield. They expressed that 180 kg K/ha gave highest total (54.69 & 47.39) and marketable (54.12 & 46.39 t/ha), respectively during the two years of experimentation [21].

Rodrigues *et al.,* (2018) concluded that the productive components of the onion were affected by N fertilization. The application of 67 kg/ha N, regardless of planting time, provided the maximum economic return for the onion crop [22].

Tekeste *et al.,* (2018) observed significant impact in mostly onion growth parameters as well as bulb traits by adding nitrogen into to soil. Similarly, application of phosphorus also showed significant observations for leaves' count, length and bulb diameter. The study also revealed significant behavior regarding interaction of nitrogen with phosphorus. They achieved highest total and marketable yield with the addition of nitrogen (103.5 kg) and phosphorus (138 kg/ha). However, application of 103.5-92 kg NP/ha showed maximum net return [23].

III. MATERIALS AND METHODS

A. Location of the experiment and facilities

A research project with title on "Impact of N-fertilization on onion bulb production of different genotypes through onion set" was conducted in Nursery Farm, Faculty of Agriculture, Gomal University Dera Ismail Khan, during the year 2019. This 2-factors study was designed in RCBD (using split-plot layout). A sub-plot size was maintained as 2m × 3m (6 m^2) and there were three replications in the experiment. Three onion varieties

were assigned to main plot, while sub-plot contained four different N-levels along with control treatment. The experimental site was set by giving three plowings and planking thereafter to prepare fine seed bed. Onion sets of the respective varieties were sown during the month of August, keeping a distance of 45 × 10 cm, respectively between successive rows and plants. A uniform application of 60 kg PK ha^{-1} was incorporated into the soil at sowing, while respective doses of nitrogen were applied in 2-splits accordingly. All the required inputs, irrigation, insect/pest, weed and maintenance was done uniformly and accordingly for whole experiment.

B. Details of treatments

Varieties (main-plot)	N-levels (sub-plot)
V_1 – Shah Alam	N_0 – control (no application of N)
V_2 – Peshawar Local	N_1 – 60 kg ha^{-1}
V_3 – Dera Local	N_2 – 120 kg ha^{-1}
	N_3 – 180 kg ha^{-1}
	N_4 – 240 kg ha^{-1}

C. Parameters to be studied
(i) Survival percentage (plot^{-1})
(ii) Days to 50% sprouting
(iii) Length of leaves (cm)
(iv) No. of leaves (bulb^{-1})
(v) Bulb diameter (cm)
(vi) No. of shoots (plant^{-1})
(vii) Bulb weight (kg)
(viii) Number of split bulbs (plant^{-1})
(ix) Bulb neck ratio leaf (kg plot^{-1})
(x) Bulb yield (t ha^{-1})

D. Methods of data collection
(i) Survival percentage (plot^{-1}). Survival of bulbs (%) for all sub plots was computed by the formula.

$$Survival\ (\%) = \frac{\text{No. of sets survived}}{\text{Total numbers of sets sown}} \times 100$$

(ii) Days to 50% sprouting. Total days from sowing were counted when 50% of plants were sprouted in each plot.

(iii) Leaf length (cm). Length of appeared leaves on five selected bulbs was measured and averaged.
(iv) Number of leaves (bulb^{-1}). Quantity of leaves appeared on five selected bulbs was counted and averaged.
(v) Bulb diameter (cm). Spread of five bulbs (plot^{-1}) was measured with Vernier caliper. Their average was calculated and noted.
(vi) Number of shoots (plant^{-1}). Five plants (plot^{-1}) were selected at random and their total shoots were counted, averaged and recorded.
(vii) Bulb weight (kg). The selected five bulbs in each plot were weighed after removing leaves, then averaged and recorded.
(viii) Number of split bulbs (plant^{-1}). Randomly 5 plants were selected per sub plot. Their split bulbs were counted, averaged and then recorded.
(ix) Bulb neck ratio leaf (kg plot^{-1}). Five different plants were selected in each plot. Ratio of their bulb and neck was calculated. After that, the bulb-neck ratio was further compared leaves and then recorded.
(x) Yield (t ha^{-1}). Recorded weight of bulbs in every plot was converted into hectare with the help of formula given below.

$$Yield\ (t\ ha^{-1}) = \frac{\text{bulb yield (kg } plot^{-1})}{\text{plot size } (m^2)} \times 10000$$

IV. RESULTS AND DISCUSSION

A. Survival percentage (plot^{-1})
Table 1 showed the data for survival percentage of plants per plot, wherein, different nitrogen levels, varieties and their interactions stood significantly different.
Survival percentage was maximum (83.52%) at 180 kg ha^{-1} nitrogen, whereas other levels had non-significant influence, as the percent survival (49.90%, 49.74% and 60.27%, respectively) for 60 kg N ha^{-1}, 120 kg N ha^{-1} and 240 kg N ha^{-1} was statistically similar with that of the check treatment (54.40%). Similarly, Shah Alam variety stood on top in terms of survival percentage (78.08%) in comparison with Dera Local (54.94%) and Peshawar Local (45.7%). The interactive studies showed that maximum survival (96.75%) of plants was achieved when nitrogen was applied at 180 kg ha^{-1} was applied to Shah Alam variety.

Table 1: Influence of various nitrogen levels on survival percentage (plot^{-1}) in onion varieties.

Nitrogen Levels (dosage ha^{-1})	Onion Varieties			Mean
	V_1 Shah Alam	V_2 Peshawar Local	V_3 Dera Local	
N_0 (control)	81.29 b	33.33 f	48.60 d	54.40 b
N_1 (60 kg)	67.84 cd	38.88 e	42.98 de	49.90 b
N_2 (120 kg)	69.24 cd	40.27 de	39.72 de	49.74 b
N_3 (180 kg)	96.75 a	74.33 bc	79.50 b	83.52 a
N_4 (240 kg)	75.26 bc	41.66 de	63.88 c	60.27 b
Mean	**78.08 a**	**45.7 b**	**54.94 b**	

Mean values in each group accompanied by common(s) letters are non-significance at 5% probability level
Critical value of comparison:
Varieties = 15.83
N levels = 13.56
Interactions = 23.50

Similarly, lowest survival (33.33%) was noted in Peshawar Local supplied with no nitrogen. It is vivid that Shah Alam variety had the maximum survival percentage among others, while 180 kg N proved as optimum dose regarding survival percentage.

It might be inferred that the differences for the parameter under observation caused by variation in genetic makeup of varieties. The applied nitrogen rates also aided in survival of plants, wherein, 180 kg N ha^{-1} maximally benefitted the plant growth which clarifies that by further increasing rate, chances of over dosage might increase which would rather have negative effects on the crop plants. Tested varying N-rates in onion varieties and found that survival percentage of plants was significantly different for both varieties and N-rates [24] & [25]. Their results support the findings of present study.

B. Days to 50% sprouting

Results on time to 50% sprouting by each onion variety (Table 2) confirmed that multiple doses of nitrogen, varieties and their combinations depicted significant influence.

Earliest 50% sprouting (24 days) was given by N_3 (180 kg ha^{-1}). All other nitrogen levels i.e. 60, 120 and 240 kg ha^{-1} did not show any significant effect as the plants under these treatments took statistically similar number of days (36.22, 33.22 and 32.11 days) to 50% sprouting as that of the control (37 days). Among varieties, Shah Alam showed least number of days (23.60) to 50% sprouting, while Peshawar Local took maximum (40.47) number of days to reach the same. Consequently, use of N_3 treatment for Shah Alam variety outmatched other combinations in reaching 50% sprouting by taking 18.33 days.

The differences in acquired values for days to 50% sprouting might have been induced due to changing genetic behavior of a particular variety. The applied nitrogen levels showed that sprouting was hastened at 180 kg N ha^{-1}. However, by more increase in nitrogen, sprouting may be delayed. Sprouting and maturity in onion may be affected by varying level of nitrogen fertilizer applied [5] & [18].

Table 2: Influence of various nitrogen levels on days to 50% sprouting in onion varieties.

Nitrogen Levels (dosage ha^{-1})	Onion Varieties			Mean
	V_1 Shah Alam	V_2 Peshawar Local	V_3 Dera Local	
N_0 (control)	28.67 bcd	45.67 a	36.67 abc	37.00 a
N_1 (60 kg)	24.00 cd	45.33 a	39.33 ab	36.22 a
N_2 (120 kg)	23.67 cd	44.33 a	31.67 abcd	33.22 a
N_3 (180 kg)	18.33 d	26.33 bcd	27.33 bcd	24.00 b
N_4 (240 kg)	23.33 cd	40.67 ab	32.33 abcd	32.11 ab
Mean	**23.6 c**	**40.47 a**	**33.47 b**	

Mean values in each group accompanied by common(s) letters are non-significance at 5% probability level

Critical value of comparison:

Varieties = 5.24
N levels = 8.48
Interactions = 14.70

C. Leaf Length (cm)

Data analysis of screened onion varieties given in Table 3 revealed that varieties, N doses as well as the interactions significantly influenced onion leaf length.

Of various N-rates used in study, 180 kg N maximally enlarged length of leaf (64.02 cm), whereas 60 kg dose followed (43.22 cm) in terms of maximum leaf length (cm). This was followed by leaf length of 38.60 and 36.96 cm obtained by giving 240 and 120 kg nitrogen, respectively. In contrast, shortest leaves measuring 34.45 cm were recorded in untreated check. Furthermore, Shah Alam showed maximum gain with respect to leaf length (55.81 cm) which was followed by statistically at par leaf lengths of 37.93 and 36.63 cm recorded for Dera Local and Peshawar Local, in respective manner.

Table 3: Influence of various nitrogen levels on leaf length (cm) in onion varieties.

Nitrogen Levels (dosage ha^{-1})	Onion Varieties			Mean
	V_1 Shah Alam	V_2 Peshawar Local	V_3 Dera Local	
N_0 (control)	43.80 de	26.11 f	33.55 ef	34.45 c
N_1 (60 kg)	61.77 b	32.22 ef	35.66 ef	43.22 b
N_2 (120 kg)	42.77 de	34.33 ef	33.77 ef	36.96 bc
N_3 (180 kg)	81.56 a	59.16 bc	51.33 bcd	64.02 a
N_4 (240 kg)	49.16 cd	31.33 ef	35.33 ef	38.60 bc
Mean	**55.81 a**	**36.63 b**	**37.93 b**	

Mean values in each group accompanied by common(s) letters are non-significance at 5% probability level

Critical value of comparison:

Varieties = 8.08
N levels = 6.31
Interactions = 10.93

Among various interactions, maximum leaf length measuring 81.56 cm was obtained in Shah Alam variety nourished by 180 kg nitrogen. Nevertheless, shortest leaf length of 26.11 cm was obtained in Peshawar Local where nitrogen was not applied. The observed differences might be attributed to the genetic variation present among varieties. It is obvious that vegetative growth of any plant is greatly influenced with the application of nitrogen, thus varying doses of nitrogen might have affected leaf length differently. Similar findings were presented and recorded different leaf lengths for different varieties when subjected to varying nitrogen doses [26].

D. Number of leaves (bulb^{-1})

Leaves' appearance (bulb^{-1}) in various onion varieties as affected by different nitrogen rates (Table 4) demonstrated significant influence of varieties, nitrogen rates and their interactions. Amongst N-rates examined, 180 kg N ha^{-1} showed maximized leaves (36.01 bulb^{-1}). This was statistically similar with number of leaves (32.14 and 31.81 bulb^{-1}) counted under 120 and 240 kg nitrogen, respectively. Onion variety, Shah Alam produced maximum number of leaves (39.44) per bulb, while Dera Local (29.94) and Peshawar Local (26.83 bulb^{-1}) had statistically analogous values for the same parameter. The interactive analysis showed that Shah Alam variety using 180 kg N showed highest leaves (51.84 bulb^{-1}), whereas Peshawar Local at same N dose showed lowest number of leaves (24.61 bulb^{-1}).

The study revealed that Shah Alam responded well to 180 kg nitrogen treatment and gave highest leaves, while at similar rate, Peshawar Local produced lowest leaves. This might be due to the different genetic makeup of two varieties causing different response to a similar dose. Dudhat *et al.,* (2010) also recorded variations in vegetative growth of onion due to application of nitrogen doses [27]. Their findings are in support of present results.

Table 4: Influence of various nitrogen levels on number of leaves (bulb^{-1}) in onion varieties.

Nitrogen Levels (dosage ha^{-1})	Onion Varieties			Mean
	V_1 Shah Alam	V_2 Peshawar Local	V_3 Dera Local	
N_0 (control)	32.02 bcd	26.01 cd	29.55 bcd	29.20 b
N_1 (60 kg)	36.60 bc	28.86 bcd	28.12 cd	31.19 b
N_2 (120 kg)	40.15 b	25.63 cd	30.64 bcd	32.14 ab
N_3 (180 kg)	51.84 a	24.61 d	31.60 bcd	36.01 a
N_4 (240 kg)	36.57 bc	29.03 bcd	29.82 bcd	31.81 ab
Mean	**39.44 a**	**26.83 b**	**29.94 b**	

Mean values in each group accompanied by common(s) letters are non-significance at 5% probability level
Critical value of comparison:
Varieties = 9.09
N levels = 4.78
Interactions = 8.28

E. Bulb Diameter (cm)

Results on bulb diameter (Table 5) showed a significant response for various N-rates and interactions among N-rates and varieties, however, varieties alone showed statistically similar results.

As regards N-doses, increased bulb diameter (3.34 cm) was recorded by using 180 kg N, which was statistically similar with 240 kg and 180 kg N ha^{-1} showing 2.91 and 2.96 cm diameter of bulbs, respectively. Maximum, but non-significant bulb dia (3.13 cm) was obtained in Shah Alam variety against the lowest (2.58 cm) recorded in Dera Local. Interactive studies showed that 180 kg N induced maximum improvement in bulb size (3.76 cm) of Shah Alam variety. Whereas, 0 kg and 60 kg N ha^{-1} gave smallest bulb diameter in Peshawar Local which was 2.06 and 2.09 cm, respectively.

Table 5: Influence of various nitrogen levels on bulb diameter (cm) in onion varieties.

Nitrogen Levels (dosage ha^{-1})	Onion Varieties			Mean
	V_1 Shah Alam	V_2 Peshawar Local	V_3 Dera Local	
N_0 (control)	2.67 ab	2.06 b	2.37 ab	2.37 b
N_1 (60 kg)	2.89 ab	2.09 b	2.38 ab	2.45 b
N_2 (120 kg)	3.10 ab	3.08 ab	2.56 ab	2.91 ab
N_3 (180 kg)	3.76 a	3.36 ab	2.95 ab	3.34 a
N_4 (240 kg)	3.26 ab	2.98 ab	2.64 ab	2.96 ab
Mean	**3.13 ^{NS}**	**2.71**	**2.58**	

Mean values in each group accompanied by common(s) letters are non-significance at 5% probability level
Critical value of comparison:
N levels = 0.74
Interactions = 1.29
NS = non-significant

The results depicted that Shah Alam variety responded well to 180 kg dosage of N, with which it showed bulbs having widest diameter. Thus, 180 kg N ha^{-1} may be optimum dose for increasing bulb diameter in Shah Alam. Rest of two varieties did not show better results at same rate, which might be due their different genetic makeup as compared to Shah Alam. Rageb *et al.,* (2018) used different N-levels in onion varieties and stated that variegated response of onion varieties was observed to variation in nitrogen rates [28].

F. Number of Shoots (plant^{-1})

Results pertaining to shoot quantity (Table 6) demonstrated significance for onion varieties and their interaction with nitrogen doses, however, nitrogen doses alone did not alter the parameter significantly.

Different N-rated had non-significant impact on shoot appearance in onion varieties. However, maximum shoots (5.18 plant^{-1}) was given by control treatment as against the minimum of 4.84 shoots produced in 240 kg N ha^{-1}. Among onion varieties, Shah Alam produced maximum shoots (6.13 plant^{-1}). Peshawar Local, on the other hand showed 4.77 shoots (plant^{-1}) which turned out to be statistically akin with Shah Alam. However, Dera Local showed least number of shoots (4.13 plant^{-1}) when compared with other two varieties in competition. Similarly, interaction of Shah Alam and 180 kg N produced highest shoots (7.22 plant^{-1}) as compared to all other interactions. Peshawar Local and control treatment remained ineffective in increasing shoots quantity as their interaction gave lowest shoots (2.99 plant^{-1}).

Genetic variation among the onion varieties caused significant difference in the results obtained for number of shoots. Abdissa *et al.,* (2011) depicted in their studies that number of shoots was significantly altered in the onion varieties under investigation [29].

Table 6: Influence of various nitrogen levels on number of shoots (plant^{-1}) in onion varieties.

Nitrogen Levels (dosage ha^{-1})	Onion Varieties			Mean
	V_1 Shah Alam	**V_2 Peshawar Local**	**V_3 Dera Local**	
N_0 (control)	5.99 a-d	2.99 d	3.99 cd	5.18 ^{NS}
N_1 (60 kg)	6.333 ab	3.99 cd	4.55 bcd	4.96
N_2 (120 kg)	6.330 abc	4.11 bcd	4.88 a-d	5.10
N_3 (180 kg)	7.22 a	4.44 bcd	5.10 a-d	4.96
N_4 (240 kg)	4.77 bcd	4.44 bcd	5.33 a-d	4.84
Mean	**6.13 a**	**4.77 ab**	**4.13 b**	

Mean values in each group accompanied by common(s) letters are non-significance at 5% probability level
Critical value of comparison:
Varieties = 1.76
Interactions = 1.75
NS = non-significant

G. Bulb weight (kg)

Data presented in Table 7 expressed that the different levels of nitrogen, varieties of onion and their interaction exhibited significant impact on bulb weight in the current study.

As regard N-levels, maximum (0.60 kg) bulb weight was recorded by using 180 kg N ha^{-1}, while the lowest (0.34 kg) was obtained in control treatment. In case of varieties, 0.57 kg bulb weight was given by Shah Alam, while it was lowest (0.26 kg) in Peshawar Local. Similarly, interaction of Shah Alam variety with 180 kg nitrogen produced heavier bulbs (0.77 kg) on numerical basis, whereas the lowest weight (0.17 kg) was achieved when no N was given to Peshawar Local.

The significant increase in bulb weight showed the responsiveness of onion bulb weight to nitrogen application and confirmed the conclusion of various authors who have reported that N contributed markedly to increase the mass of bulbs and consequently the productivity [30], [31]. Hence, these findings are in the favor of current finds.

Table 7: Influence of various nitrogen levels on bulb weight (kg) in onion varieties.

Nitrogen Levels (dosage ha^{-1})	Onion Varieties			Mean
	V_1 Shah Alam	**V_2 Peshawar Local**	**V_3 Dera Local**	
N_0 (control)	0.61b	0.17fg	0.23ef	0.34b
N_1 (60 kg)	0.43d	0.25ef	0.47d	0.38b
N_2 (120 kg)	0.62b	0.24ef	0.34de	0.40b
N_3 (180 kg)	0.77a	0.30ef	0.72a	0.60a
N_4 (240 kg)	0.41d	0.33de	0.32de	0.35b
Mean	**0.57 a**	**0.26 c**	**0.42 b**	

Mean values in each group accompanied by common(s) letters are non-significance at 5% probability level
Critical value of comparison:
Varieties = 0.09
N Levels = 0.11
Interactions = 0.13

H. Number of split bulbs (plant^{-1})

Varying nitrogen rates, onion varieties and their interactions exerted significant influence on the number of split bulbs (Table 8).

Maximum split bulbs (8.10 plant^{-1}) were obtained by N_3 (180 kg N), whereas rest of the N rates showed at par results for it, as mean values were statistically similar with each other. Lowest quantity of split bulbs (3.88 plant^{-1}) was noted in control treatment. Among varieties, Dera Local had more split bulbs (6.52) as compared to Shah Alam (4.55) and Peshawar Local (4.57 plant^{-1}). Similarly, interaction of 180 kg N and Dera Local variety showed more number of split bulbs (12.00 plant^{-1}), whereas all other interactive combinations had statistically similar values for number of split bulbs. However, no application of N to Peshawar Local showed minimum split shoots (3.66 plant^{-1}).

In present results, Dera Local responded positively to 180 kg nitrogen in terms of split bulbs quantity, which might be due to its different genetic properties as compared to the other two varieties. Similar kind of variation among onion varieties was observed by Rodrigues *et al.,* (2018) [22]. Thus, their results are in concordance with our results regarding number of split bulbs.

Table 8: Influence of various nitrogen levels on No. of split bulb (plant^{-1}) in onion varieties.

Nitrogen Levels (dosage ha^{-1})	Onion Varieties			Mean
	V_1 Shah Alam	V_2 Peshawar Local	V_3 Dera Local	
N_0 (control)	3.77 b	3.66 b	4.22 b	3.88 b
N_1 (60 kg)	3.99 b	3.99 b	4.55 b	4.18 b
N_2 (120 kg)	4.33 b	4.44 b	4.99 b	4.58 b
N_3 (180 kg)	5.99 b	6.33 b	12.00 a	8.10 a
N_4 (240 kg)	4.66 b	4.44 b	6.87 b	5.32 b
Mean	**4.55 b**	**4.57 b**	**6.52 a**	

Mean values in each group accompanied by common(s) letters are non-significance at 5% probability level

Critical value of comparison:

Varieties = 1.86
N levels = 2.73
Interactions = 4.72

I. Bulb neck ratio leaf (kg plot^{-1})

The data for bulb neck ratio leaf (Table 9) explicated that varieties, nitrogen rate and the interactions showed a significant influence.

Addition of N at 60, 180 and 240 kg ha^{-1} showed statistically akin bulb neck ratio leaf (2.64, 2.60 and 3.29 kg plot^{-1}) as of check treatment (2.49 kg plot^{-1}). However, 120 kg N showed lowest BNRL (2.37 kg plot^{-1}). Moreover, Shah Alam and Dera Local gave maximum and statistically at par BNRL (3.99 and 2.62) as compared to Peshawar Local (1.41 kg plot^{-1} BNRL). Among various interactions, maximum BNRL (4.36 kg plot^{-1}) was depicted in Shah Alam supplied with 180 kg nitrogen. Nevertheless, interaction of N_1 (60 kg) and N_4 (240 kg) with Shah Alam stood statistically similar with it as these treatments had 4.07 and 4.31 BNRL, respectively.

The obtained differences in mean values might have been caused due to differences in varietal genetic structure which caused them to respond differently to applied treatments. Hafez & Geries (2019) stated that bulb formation in onion cultivars was affected by nitrogen rates [31].

Table 9: Influence of various nitrogen levels on bulb neck ratio leaf (kg plot^{-1}) in onion varieties.

Nitrogen Levels (dosage ha^{-1})	Onion Varieties			Mean
	V_1 Shah Alam	V_2 Peshawar Local	V_3 Dera Local	
N_0 (control)	3.70 ab	0.61c	2.49 abc	2.49 ab
N_1 (60 kg)	4.07 a	0.77 c	3.09 ab	2.64 ab
N_2 (120 kg)	3.50 ab	1.32 bc	2.28 abc	2.37 b
N_3 (180 kg)	4.36 a	1.95 bc	2.13 abc	2.60 ab
N_4 (240 kg)	4.31 a	2.42 abc	3.13 ab	3.29 a
Mean	**3.99 a**	**1.41 b**	**2.62 ab**	

Mean values in each group accompanied by common(s) letters are non-significance at 5% probability level

Critical value of comparison:

Varieties = 2.57
N levels = 0.86
Interactions = 1.49

J. Bulb Yield (t ha^{-1})

Data regarding onion bulb yield (Table 10) revealed that different nitrogen rates, varieties and their interactions significantly influenced onion bulb yield.

Addition of 180 kg ha^{-1} nitrogen succeeded in achieving highest bulb yield (17.00 t ha^{-1}). It was trailed by 13.41 and 13.11 t ha^{-1} yields obtained by using 240 and 120 kg N, respectively. Minimum yield (9.19 t bulbs ha^{-1}) was recorded in control treatment where no N was used. Among onion varieties, Shah Alam produced maximum bulb yield (22.91 t ha^{-1}), whilst Dera Local and Peshawar Local followed Shah Alam by producing 11.36 and 9.35 t ha^{-1} bulb yield, respectively. These two varieties came out to be statistically similar with each other. In similar manner, maximum bulb yield among interactions was observed in Shah Alam variety which received 180 kg N (24.95 t ha^{-1}), whereas lowermost bulb production (8.70 t ha^{-1}) was noted in N_1 (60 kg) used for Peshawar Local.

Shah Alam performed better than the other two varieties under observation in all studied parameters, thus it ultimately produced maximum yield as well. Similarly, the interaction of Shah Alam with N_3 (180 kg) also gave higher most yield, as it outmatched rest of the interactions in all parameters studied. Messele, (2016) achieved variegated bulb yield for different varieties against various nitrogen levels [7]. Their findings corroborate the present research findings in terms of bulb yield.

Table 10: Influence of various nitrogen levels on bulb yield (t ha^{-1}) in onion varieties.

Nitrogen Levels (dosage ha^{-1})	Onion Varieties			Mean
	V_1 Shah Alam	V_2 Peshawar Local	V_3 Dera Local	
N_0 (control)	10.34 cd	9.17 cd	8.06 d	9.19 c
N_1 (60 kg)	15.81 b	8.70 d	8.50 d	11.00 bc
N_2 (120 kg)	18.70 b	7.23 e	13.42 bc	13.11 b
N_3 (180 kg)	24.95 a	12.25 c	13.81 bc	17.00 a
N_4 (240 kg)	17.76 b	9.44 c	13.03 bc	13.41 b
Mean	22.91 a	9.35 b	11.36 b	

Mean values in each group accompanied by common(s) letters are non-significance at 5% probability level

Critical value of comparison:

Varieties = 6.54

N levels = 2.99

Interactions = 5.18

V. SUMMARY

Results of the present study pertaining to different parameters are summarized in the following paragraphs.

The interactive studies showed that maximum survival (96.75%) of the plants was achieved when 180 kg N ha^{-1} was applied in Shah Alam.

Application of 180 kg ha^{-1} N in Shah Alam outmatched the other combinations in reaching 50% sprouting by taking 18.33 average days.

Among the various interactions, maximum leaf length measuring 81.56 cm was obtained in Shah Alam with the application of 180 kg N ha^{-1}.

The interactive analysis showed that Shah Alam variety @ 180 kg N ha^{-1} recorded maximum number of leaves bulb^{-1} which was 51.84.

Interactive studies showed that 180 kg N ha^{-1} induced maximum increase in bulb diameter of Shah Alam variety which came out to be 3.76 cm.

Interaction of Shah Alam and 180 kg N ha^{-1} produced maximum number of shoots (7.22) as compared to all the other interactions.

Similarly, interaction of 180 kg N ha^{-1} and Shah Alam produced heavier bulbs on numerical basis which were 0.72 g.

On the other hand, interaction of 180 kg N ha^{-1} and Peshawar Local showed more number of split bulbs which turned out to be 12.00, whereas all the other interactions had statistically similar values for number of split bulbs (plant^{-1}). Among various interactions, maximum BNRL was depicted in 180 kg N ha^{-1} and Shah Alam which was 4.36.

In the similar manner, maximum bulb yield among the interactions was observed in Shah Alam at a nitrogen rate of 180 kg ha^{-1} which was 24.95 t ha^{-1}

VI. CONCLUSION AND RECOMMENDATION

Keeping in view the aforementioned results, this study concluded the addition of 180 kg ha^{-1} nitrogen to onion crop raised through onion-set and produced best outcomes in almost all the studied parameters. Among three varieties, Shah Alam showed best performance than other two cultivars. Therefore, the use of 180 kg nitrogen to Shah Alam variety is best combination for getting higher production through onion set in the study area.

Conflict of Interest: The authors confirm that there is no conflict of interest associated with publication of this paper.

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