POTENTIAL OF ONION SEED PRODUCTION UNDER DIFFERENT POTASH LEVELS

Seemab Ashraf*, Mehmood ul Hassan*, Muhammad Sajid*, Awais Anwar*, Bakhtawar Zaib* Shukaib Anwar**

Department of Agriculture Hazara University, Mansehra. Pakistan
Department of Horticulture, The University of Haripur, Haripur. Pakistan

Abstract: A field trial was performed during 2015-16 to investigate the seed production potential of onion (variety Phulkara) under different potash (K) levels at SAU Tandojam using RCB design in three replicates having plot size of 5m x 3m (15m-2). Six treatments were formed including 0 kg ha-1control, 35 kg ha-1, 50 kg ha-1, 65 kg ha-1, 80 kg ha-1 and 95 kg ha-1. The growth and seed yield attributes of onion were significantly (P<0.05) affected by different K levels. The K at the rate of 95 kg ha^{-1} produced 45.46 cm plant height, 3.77 umbels $plant^{-1}$, 147.17 seeds $umbel^{-1}$, 1.33 g weight of seeds $umbel^{-1}$, 890 g seed yield $plot^{-1}$ and 593.37 kg seed yield ha^{-1}. Similarly, K @80 kg ha^{-1} produced 45.14 cm plant height, 3.75 umbels $plant^{-1}$, 146.11 seeds $umbel^{-1}$, 1.32 g weight of seeds $umbel^{-1}$, 884 g seed yield $plot^{-1}$ and 589.13 kg seed yield ha^{-1}. K application @65 kg ha^{-1} resulted in 41.43 cm plant height, 3.44 umbels $plant^{-1}$, 134.12 seeds $umbel^{-1}$, 1.21 g weight of seeds $umbel^{-1}$, 811 g seed yield $plot^{-1}$ and 540.76 kg seed yield ha^{-1}. The lower K level of 50 kg ha^{-1} resulted in 40.67 cm plant height, 3.38 umbels $plant^{-1}$, 131.63 seeds $umbel^{-1}$, 1.18 g weight of seeds $umbel^{-1}$, 796 g seed yield $plot^{-1}$and 530.74 kg seed yield ha^{-1}. The onion crop when given K only at the rate of 35 kg ha^{-1} produced 38.36 cm plant height, 3.18 umbels $plant^{-1}$, 125.68 seeds $umbel^{-1}$, 1.13 g weight of seeds $umbel^{-1}$, 760 g seed yield $plot^{-1}$ and 506.72 kg seed yield ha^{-1}. However, in control (no potash) the crop produced 33.71 cm plant height, 2.80 umbels $plant^{-1}$, 113.18 seeds $umbel^{-1}$, 0.99 g weight of seeds $umbel^{-1}$, 677 g seed yield $plot^{-1}$ and 451.08 kg seed yield ha^{-1}. It was concluded that the differences in all the growth and seed yield attributes of onion under 80 kg and 95 kg ha^{-1} potash levels were insignificant (P>0.05) suggesting that 80 kg ha^{-1} K (as sulphate of potash) was an optimum K application rate in addition to 120 kg N and 100 kg P ha^{-1} for achieving economically higher seed yield in onion variety Phulkara.

Key Words: Onion, Potash, Plant height, Growth, Yield

I. INTRODUCTION

Onion (*Allium cepa* L.), is herbaceous winter spice crop in the Amaryllidaceae (Alliaceae) family (Wikipedia, 2009, Sumanaratne *et al*. 2002) grown in Pakistan as Rabi season crop (Ullah, 2003). The onion develops distinct bulbs of varying size depending on variety (Tomar, 2009; Nasreen and Hossain, 2000). Onion is an essential part of daily human diet in Pakistan and contains all important elements, widely used in curry, chutney, and pickles etc. (Baloch *et al.* 2002; Ullah, 2003; Kabir, 2005). In Pakistan, the onion is cultivated in almost all parts of the country. The area under onion cultivation in the country during 2015-2016 was 130.6 thousand hectares with production of 1674.6 thousand tons; while during the year 2014-2015, the area under onion cultivation in the country was 130.5 thousand hectares with the production of 1671.0 thousand tons. This indicates 0.2 percent increase in the production during 2015-2016 as compared to the onion production during 2014-2015 (GOP, 2016).

The unavailability of good quality onion seeds is partly responsible for low yields (Bokshi *et al*., 1989; Brewster, 1994). There is a large gap between actual requirement of onion seed and quality seed production of onion. Onion seed production is a different technique when compared with onion cultivation for edible bulb production (Wang and Engel, 1998). The onion has become an expensive vegetable in terms of production due to lack of certified seed production within the country. Government imports onion to fulfill the domestic requirements and poor seed production could be due to many factors; of which lack of cool weather conditions to induce flowering constraints quality seed production (Asaduzzaman, *et al*. 2012).

Judicious use of fertilizers is considered as one of the most important factor that influence crop yield. Among nutrients applied, potassium is one of the most essential elements for plant growth. Its role is well documented in photosynthesis enzyme activity, synthesis of protein, carbohydrates and enabling to resist against pest and diseases (Tisdale *et al.,* 1985). Among essentially required nutrient elements, Potassium is fundamentally needed macronutrient that needed by plants in larger quantity for growth and development.

Potassium (K) is essential element needed for growth and development of plant; and K is equally important for the plant metabolism like N and P. The K is described as K_2O and has vital role in translocation of photosynthates, photosynthesis, control of ionic balance, protein synthesis, regulation of plant stomata and water use (Bob Thompson, 2010). In absence of soil applied K, the rate of K release from soil minerals is adversely affected (Jackson *et al.* 2001). There is vital contribution of K in producing higher crop yields if adequately available in soil (Hussain and Ahmed, 2000) and adequate K level leads to enhance nutrient uptake in plant and nutrient balance in soil ultimately increasing crop production (Adediran *et al.,* 2004). Due to continuous cropping the soils have become inadequate in potassium also (Jackson *et al.* 2001); and due to potassium inadequacy, the plant resistance to insect pests, diseases and other natural hazards is decreased (Ali *et al.* 2007); because K is most abundant cation in plant cells and is required in amounts greater than N (Epstein and Bloom, 2005). Since, no natural source exists to replenish it in to the soil; however due to its low levels in soils negative effects on crop yield and quality (Bajehbaj *et al.,* 2009).

The K application for onion seed production by the average farmer is very low even sometimes the farmers do not use K to the onion crop used for seed production (Akhtar *et al.* 2010; Razzaque *et al.,* 2010; Jiang *et al.,* 2008). Yadav *et al*., (2003) recommended 150 kg K_2O ha^{-1} in addition to N and P; while Tiwari *et al*., (2003) suggested 50 kg ha^{-1} as an optimum K rate but in severe K deficient soils 125 kg ha^{-1} K will be required for achieving higher seed production in onion.

Onion seed production is a different technique when compared with onion cultivation for edible bulb production. The potassium application has great effect on the seed formation and seed quality (Abd El-Aal *et al*., 2005). The application of K upto 150 kg ha^{-1} would be necessary for onion crop raised for seed production (El-Bassiouny, 2006); while 125 kg K ha^{-1} has proved as an optimum for onion seed production by El-Desuki *et al*. (2006). Abou El-Nasr and Ibrahim (2011) reported that the highest potassium fertilization rate of 150 kg K_2O ha^{-1} produced the tallest shoots, the highest number of leaves per plant, the highest fresh weight of

II. MATERIALS AND METHODS

The field trial was conducted during 2015-16 in Randomized Complete Block Design with three replicates to investigate the impact of various potash levels on the growth and seed yield of onion in a plot size of 3m x 5m ($15m^2$). In this experiment six potash levels were formed including a control to optimize the K requirement for onion crop for seed purpose. The experiment was laid-out at the orchard, Department of Horticulture, Sindh Agriculture University Tandojam. A good seed bed was prepared and a total of 18 plots were prepared. Six plots were allocated to each replication. For sowing, the onion bulbs of normal size were used. The seed bulbs were sown on both sides of the ridges manually. The seed bulbs were placed under the soil keeping sprouting point at soil surface level. The distance between ridges was maintained at 30 cm; while the plant to plant spacing will be 15 cm. The details of the treatments are as under:

Potash levels = 6

T_1 = 0 kg K ha^{-1} (Control)

T_2 = 35 kg K ha^{-1}

T_3 = 50 kg K ha^{-1}

T_4 = 65 kg K ha^{-1}

T_5 = 80 kg K ha^{-1}

T_6 = 95 kg K ha^{-1}

Mature sound healthy bulbs of various sizes as described in the treatment plants were planted in the first week of November and harvesting of mature umbels was in the third week of March. Planting was done on bedded ridges having 30 cm spacing between rows.

The potash fertilizer was applied as per the above treatment plan; while a uniform dose of nitrogen (120 kg ha^{-1}) and phosphorus (100 kg ha^{-1}) was also applied as recommended dose of these fertilizers. All P and K (in the form of single superphosphate and sulphate of potash) along with $1/3^{rd}$ of N (in the form of urea) were applied as basal dose at the time of sowing by mixing in the soil, while remaining N was divided into two equal splits.

The fertilizer application method used was broadcasting on the shoulders of the ridge below the level of the irrigation water. Irrigation was applied at 8–12 days intervals. All the necessary cultural operations were adopted throughout the growing period uniformly according to the crop requirements in all the plots till the umbels appeared to attain maturity. The crop was kept clean of weeds and manual weeding was performed carefully not to harm the experimental crop.

Mature umbels were cut with 7-10 cm of stalk and collected into bundles and left to dry under shade. Threshing was done after complete drying of the umbels and weighing of samples were conducted thereafter. The following observations were recorded on the basis of randomly selected five plants in each sub-plot.

Observations recorded

1. Plant height (cm)
2. Number of umbels plant^{-1}
3. Number of seeds umbel^{-1}
4. Weight of seeds umbel^{-1} (g)
5. Seed yield (g plot^{-1})
6. Seed yield (kg ha^{-1})

Statistical analysis:

The data were statistically analyzed using ANOVA for identify the level of treatment effect and L.S.D. test to compare the treatment means as suggested by Gomez and Gomez (1984).

AYOUT PLAN OF THE EXPERIMENT

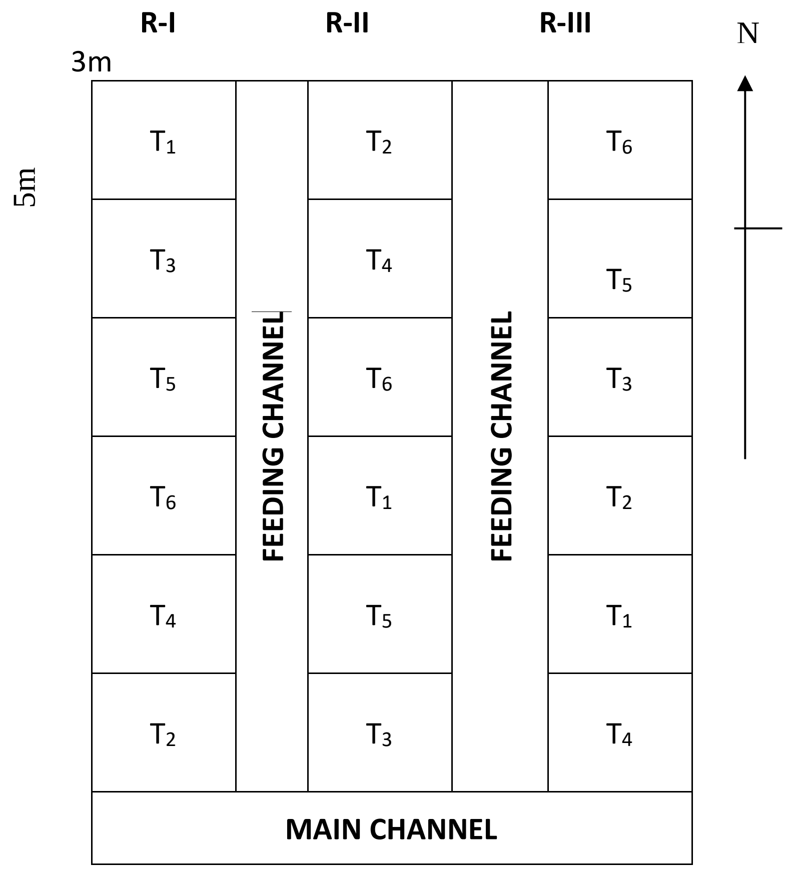
Design = RCBD

Replications = 03

Plot Size = 3 m × 5 m (15 m^2)

Treatments (K levels) = 6

T_1 = 0 kg ha^{-1}control T_2 = 35 kg ha^{-1}
T_3 = 50 kg ha^{-1}
T_4 = 65 kg ha^{-1} T_5 = 80 kg ha^{-1} T_6 = 95 kg ha^{-1}



III. RESULTS

The experiment embodied in this thesis was performed during the year

2015-2016 to investigate the seed production potential of onion under different potash levels. The Treatments included six potash levels including a control viz: T_1=0 kg ha^{-1} control, T_2=35 kg ha^{-1}, T_3=50 kg ha^{-1}, T_4=65 kg ha^{-1}, T_5=80 kg ha^{-1} and T_6=95 kg ha^{-1}. The data were recorded on various growth and seed production traits of onion which included plant height, number of umbels $plant^{-1}$, number of seeds $umbel^{-1}$, weight of seeds $umbel^{-1}$, seed yield $plot^{-1}$ and seed yield ha^{-1}. The data on these traits of economic importance are presented in Tables 1-6 and their ANOVA as Appendices I to VI. This chapter includes the data and the logical interpretation of the results for each parameter under respective sub-heading in view of the statistical analysis of the experimental data.

Plant height

The plant height is a growth trait of economic importance, because tallness of a plant reflects the varietal growth habit as well as the crop and soil management for nutrients and other inputs. The height of plant in onion for seed production is mainly guided by the amounts of nutrients supplied to the crop. Plant height of onion plantation raised for seed production through bulbs as affected by various potash levels are presented in Table-1 and its ANOVA as Appendix-I. The ANOVA suggested varied K rates had significant (P<0.05) effect on plant height of onion for seed production.

The plant height (Table 1) was significantly (P<0.01) maximum (45.46 cm) in case of onion plantation given potash at the highest rate of 95 kg ha^{-1}, followed by 80, 65 and 50 kg ha^{-1} potash levels where the average plant height was 45.14 cm and 41.43 cm, respectively. The plant height of onion further decreased to 40.67 cm and 38.36 cm when onion plantation for seed production was supplied with 50 kg and 35 kg potash levels, respectively. However, the plant height was lowest (33.71 cm) when the onion plantation for seed production purpose was kept untreated of potash and only N and P at recommended rates were applied.

The response of onion crop for seed production clearly indicated that the experimental soil was relatively deficient of available potash and there was a remarkable increase in the length of vine with each increased dose of synthetically supplied potash fertilizer. Moreover, the role of soil applied potash was seems to be diversified and it not only corrected the soil K deficiency but also improved the N and P efficiency to utilize for enhancing the plant growth. The statistical analysis showed that the differences in plant height 95 kg and 80 kg per hectare were insignificant (P>0.05). Hence for maximization of plant height in onion seed production crop, 80 kg potash would be an optimum rate of potash application synthetically.

Table 1. Mean plant height (cm) of onion variety Phulkara under the effect of different levels of potash fertilizer

Treatment (K levels)	Replications			Mean
	R-I	R-II	R-III	
T_1 = 0 kg K ha^{-1} (Control)	31.22	34.25	35.66	**33.71^E**
T_2 = 35 kg K ha^{-1}	35.2	39.44	40.45	**38.36^D**
T_3 = 50 kg K ha^{-1}	37.31	41.81	42.88	**40.67^C**
T_4 = 65kg K ha^{-1}	38.02	42.60	43.69	**41.43^B**
T_5 = 80 kg K ha^{-1}	41.42	46.41	47.59	**45.14^A**
T_6 = 95 kg K ha^{-1}	41.71	46.74	47.94	**45.46^A**

S.E.±	0.3324
LSD 0.05	0.7407
LSD 0.01	1.0536
CV %	1.06

Number of umbels plant^{-1}

The development of umbels in onion is a growth as well as seed yield contributing trait and generally reflects the vegetative performance of the plants as well as the growth habit in relation to varieties; while the crop is cultivated for seed production purpose. Number of umbels plant^{-1} in onion seedlings developed for seed production through bulbs as affected by various potash levels are shown in Table-2 and its analysis of variance is shown as Appendix-II. The ANOVA identifying the treatment effect suggested that the number of umbels plant^{-1} in onion plant was significantly ($P<0.01$) influenced by different levels of potash application.

Umbels plant^{-1} is a major trait to contribute seed production in onion and the data indicated that number of umbels was significantly ($P<0.01$) highest (3.77 plant^{-1}) in onion plantation when supplied with highest potash level of 95 kg ha^{-1}, while the number of umbels plant^{-1} reduced to 3.75 and 3.44 plant^{-1} when onion plantation was supplied with 80 and 65 kg ha^{-1} potash levels, respectively. The umbels $plant^{-1}$ further declined to 3.38 and 3.18 $plant^{-1}$ when potash rate was decreased to 50 kg and 35 kg ha^{-1}, respectively. However, the number of umbels was lowest (2.80 $plant^{-1}$) when the onion seed plants in control (no potash).

The crop response to potash levels suggested that the soil under experimental crop was K deficient and with application of synthetic potash in the form of sulphate of potash, the number of $umbels^{-1}$ in onion crop for seed production markedly increased. There was a linear association of number of umbels $plant^{-1}$ and increased potash application rates produced relatively greater number of umbels $plant^{-1}$. However, the differences in number of umbels $plant^{-1}$ under 80 kg and 95 kg K or between 50 and 65 kg ha^{-1} K were statistically non-significant (P>0.05). In view of the findings of the present research, 80 kg K per hectare would be an optimum rate for achieving maximum umbels $plant^{-1}$ in onion crop for seed production.

Table 2. Mean number of umbels $plant^{-1}$ of onion variety Phulkara under the effect of different levels of potash fertilizer

Treatment (K levels)	Replications			Mean
	R-I	R-II	R-III	
T_1 = 0 kg K ha^{-1} (Control)	2.59	2.84	2.96	**2.80^D**
T_2 = 35 kg K ha^{-1}	2.82	3.37	3.36	**3.18^C**
T_3 = 50 kg K ha^{-1}	3.10	3.47	3.56	**3.38^B**
T_4 = 65kg K ha^{-1}	3.16	3.54	3.63	**3.44^B**
T_5 = 80 kg K ha^{-1}	3.44	3.85	3.95	**3.75^A**
T_6 = 95 kg K ha^{-1}	3.46	3.88	3.98	**3.77^A**

S.E.± 0.0411
LSD 0.05 0.0916
LSD 0.01 0.1303

CV %	1.49

Number of seeds umbel^{-1}

In onion crop cultivated for seed production purpose, the character referred as seeds per umbel is a trait of great economic significance and the seed yield in is mainly influenced by this parameter. However, the number of seeds per umbel may differ in onion, but the application rate of nutrient is the main factor influencing this parameter. The results in relation to number of seeds umbel^{-1} in onion crop for seed production through bulbs as affected by various potash levels are indicated in Table-3 and its analysis of variance is given as Appendix-III. The data and the analysis of variance indicated that the number of seeds umbel^{-1} in onion plant was significantly (P<0.01) influenced by various rates of potash fertilizer.

The results showed that the seeds umbel^{-1} was maximum (147.17) in plantation under highest potash level of 95 kg ha^{-1}, while the number of seeds umbel^{-1} reduced to 146.11 and 134.12 when onion plantation was supplied with 80 kg and 65 kg ha^{-1} potash levels, respectively. The number of seeds umbel^{-1} declined to 131.63 and 125.68 in plots where 50 kg and 35 kg ha^{-1} potash was applied, respectively. However, the number of seeds was lowest (113.18 umbel^{-1}) when the onion seed plants were kept untreated for potash (control). There was a linear association of number of seeds umbel^{-1} and rates of potash application.

The results further showed that application of potash fertilizer impacted onion seed crop positively and caused a significant increase in the number of seeds umbel^{-1}. This indicates that the soil of experiment site was inadequate in potassium and synthetic K application corrected the deficiency and caused a substantial improvement in the number of seeds umbel^{-1}. However, increase in K levels upto 80 kg ha^{-1} was economical and exceeding this K level did not prove beneficial for this trait. The LSD test suggested that the differences in the number of seeds umbel^{-1} between 80 kg and 75 kg per hectare potash rates were insignificant (P>0.05). Excessiveness in available K was assumed when the synthetically applied K level exceeded 80 kg per hectare. Hence, the results concluded that 80 kg K per hectare would be an optimum rate for achieving maximum number of seeds umbel^{-1} in onion crop for seed production.

Table 3. Mean number of seeds umbel^{-1} of onion variety Phulkara under the effect of different levels of potash fertilizer

Treatment (K levels)	Replications			Mean
	R-I	R-II	R-III	
T_1 = 0 kg K ha^{-1} (Control)	113.25	110.87	115.43	**113.18^{D}**
T_2 = 35 kg K ha^{-1}	114.66	131.43	130.94	**125.68^{C}**
T_3 = 50 kg K ha^{-1}	120.78	135.33	138.79	**131.63^{BC}**
T_4 = 65kg K ha^{-1}	123.06	137.88	141.41	**134.12^{B}**
T_5 = 80 kg K ha^{-1}	134.06	150.21	154.06	**146.11^{A}**
T_6 = 95 kg K ha^{-1}	135.03	151.30	155.17	**147.17^{A}**

S.E.±	3.4209
LSD 0.05	7.6222
LSD 0.01	10.842
CV %	3.15

Weight of seeds umbel^{-1}

In onion crop cultivated for seed production purpose, the seed is developed in the umbels in varied number and seed weight may vary in each umbel developed. The seed weight per umbel is a yield attribute influences final seed yield greatly. However, the seed weight umbel^{-1} may be influenced mainly by the application rates of nutrients. The data pertaining to weight of seeds umbel^{-1} in onion crop for seed production as affected by various potash levels are presented in Table-4 and its analysis of variance is shown as Appendix-IV. The analysis of variance illustrated that the weight of seeds umbel^{-1} in onion was significantly ($P<0.01$) affected due to varying potash levels.

It is apparent from the data in Table-4 that the weight of seeds umbel^{-1} was significantly highest (1.33 g) when potash was applied at the highest level of 96 kg ha^{-1}, while the weight of seeds umbel^{-1} decreased slightly to 1.32 g when onion plantation was provided 80 kg ha^{-1} potash. A decline in weight of seeds umbel^{-1} i.e. 1.21, 1.18 and 1.13 g was recorded in plots where potash application was decreased to 65, 50 and 35 kg ha^{-1}, respectively. There was a straight effect of potash application on the weight of seeds umbel^{-1} and crop given potash at higher rates produced relatively greater weight of seeds umbel^{-1}.

The response of onion crop for seed production to K application indicated soil K deficiency and there was a remarkable increase in weight of seeds umbel^{-1} with each increased unit of synthetically supplied potash fertilizer. This also found that K application corrected the soil K deficiency and healthy seeds were developed. However, increase in the weight of seeds umbel^{-1} was economical upto 80 kg K per hectare application, exceeding this K level caused no positive effect on the weight of seeds umbel^{-1}. Statistically, the differences in weight of seeds umbel^{-1} between K levels of 80 kg and 95 kg per hectare were insignificant (P>0.05). Hence for achieving maximally healthy seeds in onion, the optimum rate of K application was 80 kg per hectare.

Table 4. Mean weight of seeds umbel^{-1} (g) of onion variety Phulkara under the effect of different levels of potash fertilizer

Treatment (K levels)	Replications			Mean
	R-I	R-II	R-III	
T_1 = 0 kg K ha^{-1} (Control)	1.02	0.92	1.04	**0.99^C**
T_2 = 35 kg K ha^{-1}	1.03	1.18	1.18	**1.13^B**
T_3 = 50 kg K ha^{-1}	1.09	1.22	1.25	**1.18^B**
T_4 = 65kg K ha^{-1}	1.11	1.24	1.27	**1.21^B**
T_5 = 80 kg K ha^{-1}	1.21	1.35	1.39	**1.32^A**
T_6 = 95 kg K ha^{-1}	1.22	1.36	1.40	**1.33^A**

S.E.± 0.0406
LSD 0.05 0.0904

LSD 0.01	0.1286
CV %	4.16

Seed yield plot^{-1}

The seed yield per unit area in onion crop for seed production is a dependent variable and this variable is entirely dependent of its contributors such as number of umbels plant^{-1}, number of seeds per umbel, seed weight per umbel^{-1} etc. However, the seed yield is influenced by soil fertility status and external use of nutrients. The umbels were harvested from each treatment and seed yield plot^{-1} was obtained separately from each plot. The data in relation to seed yield plot^{-1} as affected by various potash levels are presented in Table-5 and its analysis of variance is given as Appendix-V. The statistical analysis of data demonstrated that the seed yield plot^{-1} in onion was significantly ($P<0.01$) affected due to different rates of potash application.

The results showed that the highest seed yield of 890 g plot^{-1} was obtained from the plots given potash fertilizer at highest rate of 95 kg ha^{-1}, followed by average seed yield of 884 g and 811 g plot^{-1} in plots given potash at the rates of 80 and 65 kg ha^{-1}, respectively. The seed yield declined to 796 g and 760 g plot^{-1} when onion plantation fertilized with potash at the rates of 50 kg and 35 kg ha^{-1}, respectively. However, the seed yield plot^{-1} was minimum (677 g) in control crop where application of potash was terminated and only N and P at recommended rates were applied. There was a positive effect of increasing potash levels on the seed yield plot^{-1} and plants raised at higher K levels produced relatively greater seed yield plot^{-1} than those under lower K rates. This trend of yield variation suggested that application of K make the soil adequate of available potash optimally and hence yield increased. However, increase in K levels upto 80 kg per hectare was economical and exceeding this K level did not increase seed yield significantly. The LSD test indicated that the differences in the seed yield per plot between 80 and 95 kg per hectare were insignificant ($P>0.05$). Hence, the results suggested that 80 kg per hectare was an optimum K level to produce economically higher onion seed yields.

Table 5: Mean seed yield plot^{-1} (g) of onion variety Phulkara under the effect of different levels of potash fertilizer

Treatment (K levels)	Replications			Mean
	R-I	R-II	R-III	
T_1 = 0 kg K ha^{-1} (Control)	658	732	639	**677^{C}**
T_2 = 35 kg K ha^{-1}	693	795	792	**760^{B}**
T_3 = 50 kg K ha^{-1}	730	818	839	**796^{B}**
T_4 = 65kg K ha^{-1}	744	834	855	**811^{B}**
T_5 = 80 kg K ha^{-1}	811	908	932	**884^{A}**
T_6 = 95 kg K ha^{-1}	817	915	938	**890^{A}**

S.E.±	0.01653
LSD 0.05	0.01925
LSD 0.01	0.00086
CV %	22.36

Seed yield (kg ha^{-1})

The seed yield per hectare was calculated on the basis of seed yield plot^{-1}. The data regarding seed yield ha^{-1} of onion as affected by various potash levels are presented in Table-6 and its analysis of variance is given as Appendix-VI. The statistical analysis of the data suggested that the seed yield ha^{-1} in onion was significantly ($P<0.01$) influenced by different levels of potash fertilizer.

It is obvious from the results that the maximum seed yield of 593.37 kg ha^{-1} was achieved from the crop given potash fertilizer at highest rate of 95 kg ha^{-1}, followed by average seed yield of 589.13 kg and 540.76 kg ha^{-1} in plots given potash at the rates of 80 and 65 kg ha^{-1}, respectively. The seed yield declined to 530.74 kg and 506.72 kg ha^{-1} when onion plantation was fertilized with potash at the rates of

50 kg and 35 kg ha^{-1}, respectively. However, the seed yield ha^{-1} was lowest (451.08 kg) in control crop where application of potash was discontinued and only N and P at recommended levels were used.

The application of increased potash rates had positive impact on seed yield ha^{-1} and seed crop raised at higher K levels produced relatively greater seed yield ha^{-1} as compared to that supplied at lower K rates. However, increase in K levels upto 80 kg per hectare was economical and beyond 80 kg K level there was no economical effect on seed yield. The LSD test indicated that the differences in the seed yield per ha^{-1} between potash rates of 80 and 95 kg per hectare were insignificant ($P>0.05$). Thus, 80 kg per hectare potash was an optimum rate for economical seed production in onion.

Table 6. Mean seed yield ha^{-1} (kg) of onion variety Phulkara under the effect of different levels of potash fertilizer

Treatment (K levels)	Replications			Mean
	R-I	R-II	R-III	
T_1 = 0 kg K ha^{-1} (Control)	438.65	488.25	426.33	**451.08^C**
T_2 = 35 kg K ha^{-1}	462.31	529.93	527.94	**506.72^B**
T_3 = 50 kg K ha^{-1}	486.98	545.64	559.61	**530.74^B**
T_4 = 65kg K ha^{-1}	496.17	555.93	570.17	**540.76^B**
T_5 = 80 kg K ha^{-1}	540.55	605.66	621.17	**589.13^A**
T_6 = 95 kg K ha^{-1}	544.44	610.03	625.65	**593.37^A**

S.E.±	15.936
LSD 0.05	35.507
LSD 0.01	50.504
CV %	3.65

IV. DISCUSSION

Quality seed is the primary requirement for achieving high crop yields and unavailability of good quality onion seed is partly responsible for low yields (Bokshi *et al*., 1989). Moreover, judicious use of fertilizers is also one of the most important factors that influence crop yield and potassium is one of the essential elements required for plant growth (Tisdale *et al.,* 1985). The present study was carried out to investigate the seed production potential of onion under different potash levels. The results on various traits of economic importance are discussed in the following paragraphs:

The study showed that the plant height was significantly ($P<0.01$) maximum (45.46 cm) in case of onion plantation given potash at the highest rate of 95 kg ha^{-1}, followed by 80, 65 and 50 kg ha^{-1} potash levels where the average plant height was 45.14 cm and 41.43 cm, respectively. The plant height was lowest (33.71 cm) when the onion plantation for seed production purpose was kept untreated of potash and only N and P at recommended rates were applied. The response of onion crop for seed production clearly indicated that the experimental soil was relatively deficient of available potash and there was a remarkable increase in the length of vine with each increased dose of synthetically supplied potash fertilizer. Moreover, the role of soil applied potash was seems to be diversified and it not only corrected the soil K deficiency but also improved the N and P efficiency to utilize for enhancing the plant growth. The statistical analysis showed that the differences in plant height 95 kg and 80 kg per hectare were insignificant ($P>0.05$) and for maximization of plant height in onion seed production crop, 80 kg potash would be an optimum rate of potash application synthetically. Mathankar *et al*. (1990) reported that maximum height of plants (74.7cm) was recorded in onion crop for seed production given higher K fertilizer. However, the difference in plant height of onion for seed production obtained in the present study and achieved by above researcher might be associated with onion variety or other environmental conditions. Deho *et al*. (2002) indicated that onion variety Phulkara produced better readings for height of plant, leaves $plant^{-1}$, average plant weight and seed yield ha^{-1} and the crop was fertilized with 40 kg ha^{-1} K in addition to 80 N and 60 kg P_2O_5 ha^{-1}.

The development of umbels in onion is a growth as well as seed yield contributing trait and generally reflects the vegetative performance of the plants. Umbels $plant^{-1}$ were significantly highest (3.77 $plant^{-1}$) in onion plantation when supplied with highest potash level of 95 kg ha^{-1}, while the umbels $plant^{-1}$ reduced to 3.75 and 3.44 $plant^{-1}$ when onion plantation was supplied with 80 and 65 kg ha^{-1} potash levels, respectively; and the number of umbels was lowest (2.80 $plant^{-1}$) when the onion seed plants in control (no potash). The crop response to potash levels suggested that the soil under experimental crop was K deficient and with application of synthetic potash in the form of sulphate of potash, the number of $umbels^{-1}$ in onion crop for seed production markedly increased.

There was a linear association of number of umbels plant^{-1} and increased potash application rates produced relatively greater number of umbels plant^{-1}. However, the differences in number of umbels plant^{-1} under 80 and 95 kg K or between 50 and 65 kg ha^{-1} K were statistically non-significant (P>0.05) indicating that 80 kg K per hectare would be an optimum rate for achieving maximum umbels plant^{-1} in onion crop for seed production. These results are in line with that of Singh (2001) who found that application of higher amounts of potash fertilizer had positive impact on umbels per plant. Shobha and Pappiah (2000) reported that more umbels per plant of onion raised for seed production was recorded in crop given K was applied at the rate of 50 kg ha^{-1} in combination to 90 kg N and 90 P kg ha^{-1}.

Number of seeds per umbel may differ in onion, but the application rate of nutrient is the main factor influencing this parameter. The seeds umbel^{-1} was significantly (P<0.01) maximum (147.17) in plantation under highest potash level of 95 kg ha^{-1}, and number of seeds umbel^{-1} reduced to 146.11 and 134.12 when onion plantation was supplied with 80 kg and 65 kg ha^{-1} potash levels, respectively; while lowest (113.18 umbel^{-1}) when the onion seed plants were kept untreated for potash (control). There was a linear association of number of seeds umbel^{-1} and rates of potash application. The application of potash fertilizer impacted onion seed crop positively and caused a significant increase in the number of seeds umbel^{-1}. This indicates that the soil of experiment site was inadequate in potassium and synthetic K application corrected the deficiency and caused a substantial improvement in the number of seeds umbel^{-1}. However, increase in K levels upto 80 kg per hectare was economical and exceeding this K level did not prove beneficial for this trait. The differences in the number of seeds umbel^{-1} between 80 and 75 kg per hectare potash rates were insignificant (P>0.05). Excessiveness in available K was assumed when the synthetically applied K level exceeded 80 kg per hectare. Hence, 80 kg K per hectare would be an optimum rate for achieving maximum number of seeds umbel^{-1} in onion crop for seed production. Ghafoor *et al*. (2003) suggested 50 kg K rate in combination with 150 kg N and 100 kg P ha^{-1} gave the best results with regard to number of seeds per umbel in onion sown for seed production. Nourai *et al.* (2003) 75 kg K in K deficient soils in addition to 150 kg N and 100 kg P ha^{-1} produced better values for yield contributing traits of onion.

In onion crop cultivated for seed production purpose, the seed is developed in the umbels in varied number and seed weight may vary in each umbel developed. The weight of seeds umbel^{-1} was significantly highest (1.33 g) when potash was applied at the highest level of 96 kg ha^{-1}, and weight of seeds umbel^{-1} decreased slightly to 1.32 g when onion plantation was provided 80 kg ha^{-1} potash; while lowest was recorded on control. The response of onion crop for seed production to K application indicated soil K deficiency and there was a remarkable increase in weight of seeds umbel^{-1} with each increased unit of synthetically supplied potash fertilizer. This also found that K application corrected the soil K deficiency and healthy seeds were developed. However, increase in the weight of seeds umbel^{-1} was economical upto 80 kg K per hectare application, exceeding this K level caused no positive effect on the weight of seeds umbel^{-1}. The differences in weight of seeds umbel^{-1} between K levels of 80 kg and 95 kg per hectare were insignificant (P>0.05) and hence for achieving maximally healthy seeds in onion, the optimum rate of K application was 80 kg per hectare. Jilani (2004) maximum weight of umbel plant^{-1} under 150-100-50 kg ha^{-1} N-P-K fertilizers in onion raised for seed production. Similar results have also been reported by Islam *et al.* (2008), Mosleh-ud-Deen (2008) Ashrafuzzaman *et al.* (2009) and Deshpande *et al.* (2010) who reported that application of K resulted in improved seed weight in onion.

The seed yield per unit area in onion crop for seed production is a dependent variable and this variable is entirely dependent of its contributors such as number of umbels plant^{-1}, number of seeds per umbel, seed weight per umbel^{-1} etc. However, the seed yield is influenced by soil fertility status and external use of nutrients. The maximum seed yield of 593.37 kg ha^{-1} was achieved from the crop given potash fertilizer at highest rate of 95 kg ha^{-1}, followed by average seed yield of 589.13 kg and 540.76 kg ha^{-1} in plots given potash at the rates of 80 and 65 kg ha^{-1}, respectively; while lowest (451.08 kg) in control crop where application of potash was discontinued and only N and P at recommended levels were used. There was a positive effect of increasing potash levels on the seed yield ha^{-1} and plants raised at higher K levels produced relatively greater seed yield ha^{-1} than those under lower K rates. This trend of yield variation suggested that application of K make the soil adequate of available potash optimally and hence yield increased. However, increase in K levels upto 80 kg per hectare was economical and exceeding this K level did not increase seed yield significantly. The differences in the seed yield per plot between 80 and 95 kg per hectare were insignificant ($P>0.05$); suggested that 80 kg per hectare was an optimum K level to produce economically higher onion seed yields. Singh (2001) seed yield (723 kg ha^{-1}) was recorded when 50 kg K ha^{-1}. Shobha and Pappiah (2000) reported that the highest seed yield was recorded in crop given K was applied at the rate of 50 kg ha^{-1} in combination to 90 kg N and 90 kg P ha^{-1}. Baloch *et al.* (2002) reported onion seed yield upto 633.77 kg ha^{-1} under 70 kg K ha^{-1} in addition to 100 kg N and 75 kg P ha^{-1}. Deho *et al*. (2002) indicated that onion variety Phulkara produced better readings for seed yield ha^{-1} and the crop was fertilized with 40 kg ha^{-1} K in addition to 80 N and 60 kg P_2O_5 ha^{-1}. Nourai *et al.* (2003) 75 kg K in K deficient soils in addition to 150 kg N and 100 kg P ha^{-1} produced better seed yield results as compared to other treatments. Jilani (2004) maximum number of umbel plant^{-1}, under 150-100-50 kg ha^{-1} N-P-K fertilizers showed maximum growth and seed yield. Tomar *et al.* (2004), Nourai (2006). Asim and Abu-Sarra1 (2007), Ali *et al.* (2007) suggested N application at the rate of 150 kg ha^{-1}, P 120 kg ha^{-1} and 40-80 kg K ha^{-1} for achieving more than 515.42 kg ha^{-1} seed yield in onion.

V. SUMMARY AND CONCLUSIONS

Summary

In order to investigate the seed production potential of onion under different potash levels, the study was carried out during the year 2015-16 at

the Department of Horticulture (Horticulture Orchard), SAU Tandojam. Six treatments were formed including 0 kg ha^{-1}control, 35 kg ha^{-1}, 50 kg ha^{-1}, 65 kg ha^{-1}, 80 kg ha^{-1} and 95 kg ha^{-1}. The data were recorded on various growth and seed production traits of onion which included plant height, number of umbels plant^{-1}, number of seeds umbel^{-1}, weight of seeds umbel^{-1}, seed yield plot^{-1} and seed yield ha^{-1}. The findings of the study are summarized as follows:

The results showed that the plant height, umbels plant^{-1}, seeds umbel^{-1}, weight of seeds umbel^{-1} and seed yield ha^{-1} of onion crop sown for seed production were significantly affected by different potash application rates. The crop fertilized with highest potash level of 95 kg ha^{-1} produced 45.46 cm plant height, 3.77 umbels plant^{-1}, 147.17 seeds umbel^{-1}, 1.33 g weight of seeds umbel^{-1}, 890 g seed yield plot^{-1} and 593.37 kg seed yield ha^{-1}. The crop given potash at the rate of 80 kg ha^{-1} produced 45.14 cm plant height, 3.75 umbels plant^{-1}, 146.11 seeds umbel^{-1}, 1.32 g weight of seeds umbel^{-1}, 884 g seed yield plot^{-1} and 589.13 kg seed yield ha^{-1}. The onion crop supplied with potash at the rate of 65 kg ha^{-1} produced 41.43 cm plant height, 3.44 umbels plant^{-1}, 134.12 seeds umbel^{-1}, 1.21 g weight of seeds umbel^{-1}, 811 g seed yield plot^{-1} and 540.76 kg seed yield ha^{-1}. The crop fertilized with potash at the rate of 50 kg ha^{-1} resulted in 40.67 cm plant height, 3.38 umbels plant^{-1}, 131.63 seeds umbel^{-1}, 1.18 g weight of seeds umbel^{-1}, 796 g seed yield plot^{-1} and 530.74 kg seed yield ha^{-1}. The onion crop raised for seed production purpose given potash at the rate of 35 kg ha^{-1} produced 38.36 cm plant height, 3.18 umbels plant^{-1}, 125.68 seeds umbel^{-1}, 1.13 g weight of seeds umbel^{-1}, 760 g seed yield plot^{-1} and 506.72 kg seed yield ha^{-1}. The onion crop sown under control plots (no potash) produced 33.71 cm plant height, 2.80 umbels plant^{-1}, 113.18 seeds umbel^{-1}, 0.99 g weight of seeds umbel^{-1}, 677 g seed yield plot^{-1} and 451.08 kg seed yield ha^{-1}.

Conclusions

It was concluded that the differences in all the growth and seed yield attributes of onion under 80 kg and 95 kg ha^{-1} potash levels were insignificant ($P>0.05$) suggesting that 80 kg ha^{-1} K (as sulphate of potash) was an optimum K application rate in addition to 120 kg N and 100 kg P ha^{-1} for achieving economically higher seed yield in onion variety Phulkara.

Recommendations

The farmers are suggested to apply potash at the rate of 80 kg ha^{-1} for their onion crop for seed production purpose in addition to 120 kg N and 100 P kg ha^{-1}.

REFERENCES

[1]. Abd El-Aal, F.S., M.R. Shafeek, A.A. Ahmed and A.M. Shaheen, 2005. Response of growth and yield of onion plants to potassium fertilizer and humic acid. J. Agric. Sci. Mansoura Univ., 30(1): 315-326.

[2]. Abou El-Nasr, M. E. and E. A. Ibrahim, 2011. Effect of different potassium fertilizer rates and foliar application with some sources of

potassium on growth, yield and quality of onion plants (*Daucus carota*L.). Plant Production, Mansoura Univ., 2 (4): 559-569.
[3]. Adediran, A.J., B.L. Taiwo, O.M. Akande, A.R. Sobule and J.O. Idowu, 2004. Application of organic and inorganic fertilizer for sustainable maize and cowpea yields in Nigeria. J. Plant Nutr., 27: 1163–81
[4]. Akhtar, M.E., M.Z. Khan, M.T. Rashid, Z. Ahsan and S. Ahmad. 2010. Effect of potash application on yield and quality of tomato (*Lycopersicon esculentum* Mill.). Pak. J. Bot., 42 (3): 1695-1702.
[5]. Ali, M.K., M. F. Alam, M. N. Alam, S. Islam and S. M. A. T. Khandaker. 2011. Effect of nitrogen and potassium level on yield and quality seed production of onion. Journal of Plant Sciences. 21 (1) : 215-222.

[6]. Ali, M.K., M.F. Alam, M.N. Alam, M. S. Islam and S.M.A.T. Khandaker. 2007. Effect of Nitrogen and Potassium Level on Yield and Quality Seed Production of Onion. Journal of Applied Sciences Research, 3(12): 1889-1899.
[7]. Asaduzzaman, J.W., Kuhar, T.P. and Hoffmann, M.P. 2015. Monitoring and forecasting for disease and insect attack in onions and Allium crops within IPM strategies. In: Allium crop science: Recent advances (eds H.D Rabinowitch and L. Currah). CABI, Wallingford, UK pp. 293-309.
[8]. Asaduzzaman, M.D., M. Hasan, M. Hasan and K. Moniruzzaman. 2012. Quality seed production of onion (*Allium cepa* L.): an integrated approach of bulb size and plant spacing. J. Agric. Res. 50 (1) : 119-128
[9]. Ashrafuzzaman, M., M. N. Millat, M. R. Ismail, M.K. Uddin, S.M. Shahidullah and S. Meon. 2009. Paclobutrazol and bulb size effect on onion seed production. Int. J. Agric. Biol., 11(3) : 245–250.
[10]. Asim, F. and Abu-Sarra1. 2007. Effects of mother bulb size and nitrogen nutrition on production of red onion Seeds at Rahad Scheme. Expl. Agric, 5 (7) : 147 – 149.
[11]. Bajehbaj, S. M. A., Farooq, M. and Tabassum, R. 2009. Physiological and biochemical aspects of seed vigour enhancement treatments in fine onion. Seed Sci Tech. 33: 25-29.
[12]. Baloch, A.F., M.A. Baloch and S.A. Magsi. 2002. Effect of different planting dates, bulb sizes and cut treatments on onion seed production. Pak. J. Agri., Agril. Engg. Vet. Sci. 18 (1-2) : 10-13.
[13]. Bob Thompson. 2010. Efficient Fertilizer Use-Potassium:
[14]. Bokshi, A.I., Mondal, M.F., Pramanik, M.H.R., 1989. Effects of nitrogen and phosphorus fertilizers on the yield and quality of onion seeds. Bangladesh Horticulture, 17(2): 30-35.
[15]. Brewster, J.L., 1994. Onions and Other Vegetable Alliums. CAB International, Wallingford, UK, 236 pp
[16]. Deho, N. A., M. R. Wagan, M. K. Baloach, I. Rajpar, and K. I. Keerio. 2002. NPK trial on onion (*Allium cepa* L.). Pakistan Journal of Applied Sciences, 2 (8) : 820-821.
[17]. Deshpande, A.N., A.R. Dhage, V.P. Bhalerao and S.K. Bansal. 2010. Potassium nutrition for improving yield

and quality of onion. Journal of Plant Science. 32 (1) : 158-160.

[18]. El-Bassiouny, A.M., 2006. Effect of potassium fertilization on growth, yield and quality of onion plants. J. Appl.

[19]. El-Desuki, M., M.M. Abdel-Mouty and H.A. Aisha, 2006. Response of onion plants to additional dose of potassium application. J. Appl. Sci. Res., 2(9): 592-597.

[20]. Epstein E., Bloom A.J. 2005. Mineral Nutrition of Plants: Principles and Perspectives 2nd edn. Sunderland, MA, USA: Sinauer Associates

[21]. Fathy, E. E. and M. M. El-Hamady, 2007. Response of cowpea plants (*Vigna unguiculata* L.) to some biostimulants and organic nutrients during late summer season. J. Product. Dev., 12 (1): 237-250.

[22]. Ghafoor, A., M.S. Jilani, G. Khaliq and K. Waseem. 2003. Effect of different NPK levels on the growth and yield of three onion *Allium cepa* L. varieties. Asian Journal of Plant Sciences, 2 (3) : 342-346.

[23]. Gomez, K. A. and A. Gomez, 1984. Statistical procedure for agricultural research., pp: 1-68.

[24]. Hussain, M.M. and T. Ahmed. 2000. Nitrogen use efficiency and recovery from N fertilizer under rice based cropping systems. Aust. J. Crop Sci. 3:336-351

[25]. Jackson, K.J., Duff, A.A., and O'Donell, W.E. 2001. Tebuconazole (Folicur) shows potential in the control of white rot (Sclerotium cepivorum) in garlic in subtropical Queensland, Australia. Acta Hortic. 555: 247–250.

[26]. Jiang, Q., H. Zhang, G. Ai, Q.S. Jiang and H.L. Zhang, 2008. Application of potassium fertilizer in onion production.China-Vegetables. Liangshan Agricultural Bureau, Liangshan, Shandong 272600, China. No. 4, 38.

[27]. Jilani, M.S. 2004. Studies on the management strategies for bulb and seed production of different cultivars of onion, *Allium cepa* L. Ph.D thesis, Gomal University, D.I. Khan.

[28]. Kabir, A. 2005.Recurring onion shortage. Pakistan Agriculture Experts and Institutes Network. Pakissan. Pp. 1-5.

[29]. Karakurt, Y., H. Unlu and H. Padem, 2009. The influence of foliar and soil fertilization of humic acid on yield and quality of pepper. Acta Agric. Scandinavica, 59 (3): 233-237.

[30]. Mosleh-ud-Deen, M. 2008. Effect of mother bulb size and planting time on growth, bulb and seed yield of onion. Bangladesh J. Agril. Res. 33(4) : 531-537.

[31]. Nasreen, S. and A.K.M. Hossain, 2000. Influence of chemical fertilizes and organic manure on the growth and yield of onion. Bangladesh J. Agric. Res., 25(2): 221-231

[32]. Nourai, A. 2006. Review of research on onion *Allium cepa* L. seed production in the Sudan. ISHS Acta Horticulturae 143: VIII African Symposium on Horticultural Crops, 5 (2/3) : 102-105.

[33]. Nourai, A. H., El Fahal, E. M. and Maximous, A. S., 2003. Effects of mother bulb size, plant population, nitrogen nutrition and frequency of irrigation on seed yield and seed yield components of the red onion (Allium cepa L.) in the arid tropics of northern Sudan. Proceedings of the Crop Husbandry Committee, 16 – 17 June, 2003, ARC. Wad Medani, Sudan

[34]. Razzaque,, A.H.M., M.I. Ali and A.K.M. Habibullah 2010. Response of Boro rice to potassium application in two soils of Bangladesh. Bangladesh J. Soil Sci., 21(1): 26-29.

[35]. Rohini, N and P. Paramaguru. 2016. Seasons' influence on bulb, seed yield and quality of aggregatum onion, Allium cepa var aggregatum, International Journal of Farm Sciences, 6(1): 174-183.

[36]. Saud, S., j. Chun, M. Razaq, M. Luqman, S. fahad, M. Abdullah, and A. Sadiq, 2013. Effect of potash levels and row spacing on onion yield. Journal of Biology, Agriculture and Healthcare, 3(16):118-127.

[37]. Shafeek, M.R., Nagwa M. K. Hassan, S. M. Singer and Nadia H. M. El-Greadly, 2013. Effect of potassium fertilizer and foliar spraying with Etherel on plant development, Yield and bulb Quality of onion plants. Journal of Plant Science. 65 (1) : 215-220.

[38]. Shobha, N., C. M. Pappiah. 2000. Nutritional studies in seed propagated aggregatum (small) onion. South Indian Horticulture, 48 (1/6) : 105-107.

[39]. Shrawan, S. P . K. Yadav and S. Balbir. 2004. Effect of nitrogen and potassium on growth and yield of onion (*Allium cepa* L.) cv. Pusa Red. Haryana J. of Hort. Sci,. 33 (3-4): 308-309. (c.a. CAB Abstr.).

[40]. Tisdale, S.L. W.L. Nelson, J.D. Beaton. 1985. Micronutrients and other beneficial elements in soils and fertilizers. In soil fertility and fertilizers, Zinc, spp.387-388. Macmillan Publishing Company 866 third avenue, New York, 10022.

[41]. Tiwari, R.S., A. Ankur and S.C. Sengar. 2003. Effect of bio regulators, bulb yield, quality and storability of onion cv. Pusa Red. Indian J. Plant Physiol., 8(4): 411-413.

[42]. Tomar, B., S. Singh and M. Hassan. 2004. Effect of bulb weight and size on seed yield and seed quality in onion cv. Pusa Madhavi. Seed Research, 32 (1) : 123-127.

[43]. Tomar, B.S. 2009. Quality seed production technology of Onion Crops in India. KrishiSewa.Com. bst_spu_iari@rediffmail.com.

[44]. Ullah, M.M. 2003. Nutrien management in summer onion. Ph.D. Thesis. Dept. of Soil Science. Bangabandhu Sheikh Mujibur Rahman Agric. Univ., pp: 150.

[45]. Wang, E. and T. Engel. 1998. Simulation of phenological development of wheat crops. Agricultural Systems, v.58, p.1-24.

[46]. Wikipedia. 2009. Onion: Wikimedia Foundation, Inc., a non-profit organization, last updated on 5th June, 2009.

[47]. Yadav, R.L., N.L. Son and B.L. Yadave, 2003. Response of onion to nitrogen and potassium fertilization under semi-arid condition of Rajasthan. Indian J. Hortic. 60 (2) : 76-178.

Authors

1st Author: Seemab Ashraf: Lecturer, Department of Agriculture, Hazara University, Mansehra, 21300, Khyber Puhtunkhwa, Pakistan.

2nd Author: Mehmood ul Hassan:Lecturer Department of Agriculture, Hazara University, Mansehra, 21300, Khyber Puhtunkhwa, Pakistan,

3rd Author: Muhammad Sajid:Associate Professor Department of Agriculture, Hazara University, Mansehra, 21300, Khyber Puhtunkhwa, Pakistan,

4th Author: Awais Anwar: Lecturer
Department of Agriculture, Hazara University, Mansehra, 21300, Khyber Puhtunkhwa, Pakistan,
5th Author: Bakhtawar Zaib: Lecturer
Department of Agriculture, Hazara University, Mansehra, 21300, Khyber Puhtunkhwa, Pakistan,
6th Author: Shukaib Anwar: Ph.D Scholar
Department of Horticulture, The University of Haripur, Haripur, 21300, Khyber Puhtunkhwa, Pakistan,