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Effect of different levels of NPK on seed yield of onion cv. Akola Safed

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Abstract
A field experiments were conducted during the *rabi* season of 2015-16 and 2016-17 at Main Garden, Department of Horticulture, Dr. PDKV, Akola, to study the effect of different levels of NPK on seed yield of onion Cv. Akola Safed. The treatments consisted of factorial combinations of three levels of each nitrogen (0, 100, 150 kg ha^{-1}), phosphorus (0, 50, 75 kg ha^{-1}) and potassium (0, 50, 75 kg ha^{-1}) laid out in factorial randomized block design with three replications. Results of the two years experiment revealed that, number of primary and secondary umbels per plant, number of seeds per primary and secondary umbel, seed weight per plant and seed yield per hectare were found to be maximum with an application of 150 Kg N ha^{-1}, 75 Kg P_2O_5 ha^{-1} and 50 Kg K_2O ha^{-1}. However, an application of 150 Kg nitrogen (N_2), 75 Kg phosphorus (P_2) and 75 Kg potassium (K_2) per hectare produced maximum diameter of primary and secondary umbel.

Keywords: NPK, seed yield, onion cv. Akola Safed

Introduction
Among all vegetable crops, onion *(Allium cepa* L.) is the important vegetable crop belong to Alliaceae family. It is a native of Asia and perhaps introduced from Palestine to India. It is important bulbous crop used widely both as condiments and vegetable. It is also popularly used both in mature and immature bulb stages as vegetable and its cultivation is expanding owing to great demand for domestic consumption as well as export as spice crop. India ranked first in area of 1203 thousand hectares, second in production of 19402 thousand metric tonnes and productivity of 16.13 metric tonnes per hectares of onion in the world (Dhatt, 2017). Maharashtra stands first in total production of onion in the country. Onion is cultivated throughout the India, but the most important onion producing states in India are Maharashtra, Karnataka, Orissa, Uttar Pradesh, Gujrat, Andhra Pradesh and Tamilnadu.
Onion seed is very short lived and retains the viability only for a year. Considering importance of pure, true-to-type seed, it is essential to standardize technology of onion seed production. Quality and quantity of seed produced per unit area greatly varies with the variety, time of planting, spacing, size of mother bulbs, method of seed production and environmental conditions. Furthermore, in addition to this, plant nutrition play an important role in quality seed production and increase the seed yield of onion considerably. Therefore, taking into consideration of these basic facts, present investigation has been proposed to study the effect of different levels of NPK on seed yield of onion cv. Akola Safed.

Materials and Methods
The research work was conducted at Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *rabi* season of the years 2015-16 and 2016-17. The experiment were conducted in factorial randomized block design with three replications and twenty seven treatment combinations. The treatments consisted of factorial combinations of three levels of nitrogen (0, 100, 150 kg ha^{-1}), phosphorus (0, 50, 75 kg ha^{-1}) and potassium (0, 50, 75 kg ha^{-1}). The half dose of nitrogen in the form of urea and full dose of phosphorus and potassium (Single super phosphate and Muraite of potash, respectively) were applied at the time of planting. Remaining half dose of nitrogen is applied 30 DAP. The bulbs of 4-6 cm diameter and having 60-80 g weight were planted along one side of the ridge at a spacing of 60 cm X 30 cm. All the required cultural practices such as irrigation, weeding, etc. were given uniformly and performed as necessary. About 10 percent of the heads were exposed black seed, harvesting was done by cutting or snapping of seed heads (umbels) with a quick turn of the hand, leaving a short piece of stem attached. The data obtained on various parameters was statistically analyzed as per the methods suggested by Panse and Sukhatme (1967) [11]

Results and Discussion

Number of primary and secondary umbels per plant

Effect of nitrogen levels

Significantly the maximum number of primary (6.07) and secondary umbels (3.51) per plant were found in treatment N_2. Whereas, the minimum number of primary and secondary umbels per plant were observed in treatment N_0 (3.31 and 1.56, respectively), during the year 2015-16.

In the year 2016-17, the treatment N_2 had produced significantly the maximum number of primary and secondary umbels per plant (6.43 and 3.89, respectively). However, significantly the minimum number of primary and secondary umbels per plant (3.54 and 1.64, respectively) were recorded in treatment N_0 (Table 1). Maximum number of umbels in onion plant grown with the treatment due to higher nitrogen uptake favored the vegetative growth, which in turns played vital role in synthesis of carbohydrates and simultaneously governed higher utilization of phosphorus, which is essential for production of maximum umbels per plant. Similar results have been discussed by the earlier workers El-Damarany *et al.* (2016) [6] in onion.

Effect of phosphorus levels

During the year 2015-16, maximum primary and secondary umbels per plant (5.40 and 2.94, respectively) were noted in treatment P_2. Whereas, the treatment P_0 produced significantly the minimum primary and secondary umbels per plant (4.12 and 2.10, respectively).

In the year 2016-17, the treatment P_2 had produced significantly the maximum primary and secondary umbels per plant (5.72 and 3.14, respectively). However, significantly the minimum (4.61) primary and (2.38) secondary umbels per plant were recorded in treatment P_0 (Table 1). Production of maximum number of primary and secondary umbels per plant would be due to the fact that, an adequate supply of phosphorus during plant growth is responsible for the enhanced growth of reproductive parts of the plant like emergence of umbels in onion. The results obtained in the present investigation are in close agreement with the findings of Ahmed and Abdalla (1984) [2] and Sedera (1999) [12] in onion.

Effect of potassium levels

During the year 2015-16 and 2016-17, the treatment K_1 was recorded maximum primary (5.19 and 5.64, respectively) and secondary (2.89 and 3.07, respectively) umbels per plant. Whereas, minimum primary (4.29 and 4.38, respectively) and secondary (2.15 and 2.41, respectively) umbels per plant in the treatment K_0 (Table 1). This could happen in the bulb crop like onion, due to the fact that, an application of optimum dose of potassium might be responsible for increase in vigour and disease resistance to plant, which might help to increase number of primary umbels per plant. The results of the present investigation are supported by the findings of Khewle (2009) [9] and El-Damarany *et al*. (2016) [6] in onion.

Diameter of primary and secondary umbels (cm)

Effect of nitrogen levels

Significantly the maximum diameter of primary (6.81 cm) and secondary (5.53 cm) umbels were found in treatment N_2. Whereas, the minimum diameter of primary and secondary umbels were observed in treatment N_0 (6.31 cm and 5.06 cm, respectively), during the year 2015-16.

In the year 2016-17, the treatment N_2 had produced significantly the maximum diameter of primary and secondary umbels (7.00 cm and 5.68 cm, respectively). However, significantly the minimum diameter of primary and secondary umbels were recorded (6.46 cm and 5.18 cm, respectively) in treatment N_0 (Table 1). The results obtained in the present investigation are in close agreement with the finding of El-Damarany *et al*. (2016) [6] in onion.

Effect of phosphorus levels

In the year 2015-16, the treatment P_2 recorded significantly the maximum diameter of primary and secondary umbels (6.73 cm and 5.45 cm, respectively). However, the treatment P_0 recorded significantly the minimum diameter of primary and secondary umbels (6.42 cm and 5.18 cm, respectively). During the year 2016-17, the treatment P_2 recorded significantly the maximum diameter of primary and secondary umbels (6.89 cm and 5.57 cm, respectively). Whereas, the treatment P_0 recorded minimum number of primary and secondary umbels per plant (6.55 cm and 5.29 cm, respectively) (Table 1). The results obtained in the present investigation are in close agreement with the findings of Sedera (1999) [12] in onion.

Effect of potassium levels

During the years 2015-16 and 2016-17, the treatment K_2 was produced the onion plants with significantly the maximum diameter of primary umbels (7.00 cm and 7.16 cm, respectively) and secondary umbels (5.66 cm and 5.79 cm, respectively). However, the minimum diameter of primary umbels (5.96 and 6.09 cm, respectively) and secondary umbel (4.80 cm and 4.91 cm, respectively) were recorded in the treatment K_0 (Table 1). The earlier worker Khewle (2009) [9] have also reported similar findings in onion.

Number of seeds per primary and secondary umbel

The pooled data in respect of seeds per primary umbel during the year 2015-16 and 2016-17 as influenced by nitrogen, phosphorus and potassium levels were presented in Table 2 (a).

Effect of nitrogen levels

The treatment N_2 recorded significantly the maximum number of seeds per primary and secondary umbel (713.17 and 526.80, respectively), whereas treatment N_0 recorded minimum number of seeds per primary and secondary umbel (511.88 and 361.77, respectively). The large number of seeds per primary and secondary umbels would probably due to large size of umbel. The application of nitrogen would might be responsible for vigorous plant growth and greater synthesis of carbohydrate in plant, which might be resulting in higher flower and seed set and ultimately yields large number of seeds per umbels. The results of the present investigation are supported by the findings of Chavan (1975) [3] and Khewle (2009) [9] in onion.

Effect of phosphorus levels

The treatment P_2 recorded significantly the maximum number of seeds per primary and secondary umbel (651.27 and 476.07, respectively). However, significantly minimum number of seeds per primary and secondary umbels (583.66 and 421.04, respectively) were observed in treatment P_0. More number of seeds per umbel could be attributed by the fact that, due to application of phosphorus with highest level. The phosphorus is an integral component of DNA and RNA, that contain the genetic code of plant to produce proteins and other compounds essential for production procedure of seeds and which would ultimately converted into more seed yield. Similar results have been recorded by the earlier workers, Sedera (1999) [12] and Ali *et al*. (2008) [1] in onion.

Effect of potassium levels

The pooled results indicated that, the treatment K_1 recorded significantly the maximum number of seeds per primary and secondary umbel (652.93 and 477.44, respectively). On the other hand, treatment K_0 recorded significantly the minimum number of seeds per primary and secondary umbel (568.64 and 408.28, respectively). Application of optimum dose of potassium might help to produce large size of umbel, its early emergence and largest resource available for seed setting and development. Further, it play vital role in photosynthesis, translocation of photosynthates and activation of various enzymes in plant, which ultimately resulted in the production of large number of seeds per umbel. Similar results have been recorded by the earlier workers like Khewle (2009) [9] and El-Damarany *et al*. (2016) [6] in onion.

Interaction effects

Interaction effects between nitrogen and phosphorus

The pooled results in respect of seeds per primary and secondary umbel were presented in Table 2(b) and significantly influenced due to the interaction effect of nitrogen and phosphorus levels. However, the treatment combination N_2P_2 produced maximum number of seeds per primary and secondary umbel (740.60 and 549.28, respectively). Whereas, minimum seeds per primary and secondary umbel (476.28 and 333.78, respectively) were recorded in the treatment combination N_0P_0. Increased root mass due to an application of nitrogen is mostly responsible for increased plant uptake of phosphorus. More availability of phosphorus might be responsible for early root growth and proliferation, which might resulted into desired nitrogen uptake. Hence, application of nitrogen and phosphorus in conjugation with each other, might resulted into higher number of seeds per umbel. Similar results have been recorded by the earlier workers like Ahmed and Abdalla (1984) [2] in onion.

Interaction effects between nitrogen and potassium

Pooled data specified in Table 2 (c) revealed that, treatment combination N_2K_1 produced maximum seeds per primary and secondary umbel (728.98 and 539.75, respectively). Whereas, the minimum seeds per primary and secondary umbel (448.42 and 309.58, respectively) were recorded in the treatment combination N_0K_0. It is well known fact that, optimum application of potassium is responsible for higher activity of photosynthesis, thereby enhanced enzyme activity and translocation of carbohydrates, which ultimately increased nitrogen uptake assimilation in plant. Vigorous excessive vegetative growth some time influence occurrence of diseases and pests, which would be counteracted by application of optimum dose of potassium. Hence, combined efficient use of nitrogen and potassium might resulted into better plant growth and ultimately produced maximum number of seeds per umbel. The results obtained in the present investigation are in close agreement with the findings of Mishra (1994), Rahim *et al*. (1997) and El-Damarany *et al*. (2016) [6] in onion.

Interaction effects between phosphorus and potassium

The pooled results in view to seeds per primary and secondary umbel were presented in Table 2(d). The treatment combination P_2K_2 produced maximum number of seeds per primary and secondary umbel (678.19 and 498.14, respectively). However, minimum seeds per primary and secondary umbel (513.88 and 364.58, respectively) were recorded in the treatment combination P_0K_0. In the crop like onion, phosphorus uptake and its full utilization in plant is governed by osmatic and water balance maintained by optimum potassium supply. Hence, combined use of phosphorus and potassium might be responsible for greater physiological activity of plant, which ultimately might be resulted into maximum seeds per umbel. These findings are in harmony with the results obtained by Majumder (2011) [10] and Howlader *et al*. (2012) in onion.

Interaction effect between nitrogen, phosphorus and potassium

The pooled data (Table (e)) indicated that, significantly the maximum seeds per primary and secondary umbel (765.18 and 569.42, respectively) in onion were recorded in treatment combination $N_2P_2K_1$. Whereas, the treatment combination $N_0P_0K_0$ had recorded minimum seeds per primary and secondary umbel (438.62 and 305.08, respectively). Maximum seeds per umbel in onion were produced in this treatment combination attributed to the fact that, balanced fertilization with all the primary nutrients *viz*. nitrogen, phosphorus and potassium supplemented with optimum moisture conditions achieved through proper irrigation and good climatic conditions throughout the growth period might be resulted in better plant stand. It seems that, increased dose of nitrogen might accelerate the vegetative growth i.e. height, number of leaves. Further, increased dose of phosphorus might be responsible for more number of seeds per primary and secondary umbel in the present study. Potassium exerts a blanching role or toxicity thereof on the effect of both nitrogen and phosphorus towards dimensions of umbels and its content of seed in slightly reduced quantity. Further, the antagonistic effect of potassium was found to be considerable, when the soil calcium content was reported to be in the range of 8.1 to 8.5 % in present investigation (Jakobsen, 1993) [8], will also equally responsible for reduced number of seeds per umbel to some extend in the crop like onion. Similar results have been recorded by the earlier workers like Dingre *et al*. (2016) [5] in onion.

Seed weight per plant (g) and seed yield per hectare (q)

Effect of nitrogen levels

The pooled data furnished in Table 2 (a) found that, significantly the maximum seed weight per plant and seed yield per hectare (27.85 g and 12.94 q, respectively) were obtained in treatment N_2. However, the treatment N_0 recorded significantly the minimum seed weight per plant and seed yield per hectare (21.04 g and 9.44 q, respectively). This might be due to the more number of graded seeds per primary and secondary umbel, which would have recorded maximum weight of the seeds per umbel and maximum seed weight per plot. Similar results have been recorded by the earlier workers Chavan (1975) [3], Ahemed and Abdalla (1984) [2] and Khewle (2009) [9] in onion.

Effect of phosphorus levels

The pooled data indicated that, the treatment P_2 observed

Significantly the maximum seed weight per plant and seed yield per hectare (25.75 g and 12.25 q, respectively). Whereas, the treatment P_0 noticed significantly the minimum seed weight per plant and seed yield per hectare (23.51 g and 10.68 q, respectively) Table 2 (a). In bulbous crop like onion, the enhanced vigorous growth and development of reproductive parts of onion plant like umbel number and size, seed number and size might be achieved through higher application of phosphorus, which might be resulted into maximum seeds per umbel and thereby seed yield per plot. Similar results have been recorded by the earlier workers like Sedera (1999) [12] and Ali *et al*. (2008) [1] in onion.

Effect of potassium levels

The pooled data directed that, the treatment K_1 measured significantly the maximum seed weight per plant and seed yield per hectare (25.82 g and 12.06 q, respectively). However, the treatment K_0 recorded significantly the minimum seed weight per plant and seed yield per hectare (22.92 g and 11.04 q, respectively) Table 2 (a). An application of optimum dose of potassium might help to produce large size of umbel, its early emergence and thereby produced large number of seeds per umbel and ultimately maximum seed yield per plot. The results of present investigation are in close agreement with the findings of Khewle (2009) [9] and El-Damarany *et al*. (2016) [6] in onion.

Interaction effects

Interaction effects between nitrogen and phosphorus

The pooled results in respect of seed weight per plant and seed yield per hectare were presented in Table 2(f). The treatment combination N_2P_2 produced maximum seed weight per plant and seed yield per hectare (28.75 g and 13.41 q, respectively). Whereas, minimum seed weight per plant and seed yield per hectare (19.85 g and 8.09 q, respectively) were recorded in the treatment combination N_0P_0. Production of higher seed yield per plot with higher level of nitrogen and phosphorus in the present investigation might be justified with the fact that, increased root mass due to application of nitrogen is largely responsible for increased plant uptake of phosphorus. At the same time higher availability of phosphorus might responsible for early root growth and proliferation, which might resulted into desired nitrogen uptake. Hence, application of nitrogen and phosphorus in conjugation might resulted into maximum number of seeds per umbel, seed weight per plant and ultimately the seed yield per plot. The results of the present investigation are in harmony with findings of Ahmed and Abdalla (1984) [2] in onion.

Interaction effects between nitrogen and potassium

The pooled results in respect of seed weight per plant and seed yield per plot were exhibited significant influence due to the interaction effect of nitrogen and potassium levels treatment and presented in Table 2(g). However, the treatment combination N_2K_1 produced maximum seed weight per plant and seed yield per hectare (28.41 g and 13.35 q, respectively). However, minimum seed weight per plant and seed yield per hectare (18.86 g and 8.53 q, respectively) were recorded in the treatment combination N_0K_0.This might be due to the fact that, optimum level of potassium application might increases nitrogen uptake with an assimilation in plant. Hence, combined efficient use of nitrogen and potassium might resulted into better plant growth and ultimately maximum seed weight per plot. The results obtained in the present investigation are in close agreement with the findings of El-Damarany *et al.* (2016) [6] in onion.

Interaction effects between phosphorus and potassium

The pooled results in respect of seed weight per plant were significantly influenced due to the interaction effect of phosphorus and potassium levels (Table 2(h). However, the treatment combination P_2K_1 produced maximum seed weight per plant and seed yield per hectare (26.64 g and 12.88 q, respectively). Whereas, minimum seed weight per plant and seed yield per hectare (21.14 g and 10.13 q, respectively) were recorded in the treatment combination P_0K_0. The maximum seed yield of onion with this treatment combination could be ascertained with phosphorus uptake and its full utilization in plant, which was governed by osmatic and water balance maintained by optimum potassium supply. Hence, there would be the possibility of combined use of phosphorus and potassium, which might be responsible for greater physiological activities of plant and thus resulted into maximum seed yield of onion. These findings are in harmony with the results of Majumder (2011) [10] in onion.

Interaction effects between nitrogen, phosphorus and potassium

The pooled data presented in Table 2(i) revealed that, significantly the maximum seed weight per plant and seed yield per hectare (29.64 g and 14.12 q, respectively) in onion was recorded in treatment combination $N_2P_2K_1$. Whereas, the treatment combination $N_0P_0K_0$ had recorded minimum seed weight per plant and seed yield per hectare (18.47 g and 7.18 q, respectively). These results are in line with the findings of earlier workers like Dingre *et al*. (2016) [5] in onion.

Table 1: Effect of nitrogen, phosphorus and potassium levels on number of primary and secondary umbels per plant

Treatments	Primary umbels per plant		Secondary umbels per plant		Diameter of primary umbels (cm)		Diameter of secondary umbels (cm)	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Nitrogen (N)								
N_0 - 0 Kg ha^{-1}	3.31	3.54	1.56	1.64	6.31	6.46	5.06	5.18
N_1 - 100 Kg ha^{-1}	5.18	5.58	2.72	2.98	6.65	6.78	5.41	5.52
N_2 - 150 Kg ha^{-1}	6.07	6.43	3.51	3.89	6.81	7.00	5.53	5.68
‘F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m) ±	0.13	0.13	0.20	0.14	0.03	0.03	0.01	0.01
CD at 5%	0.36	0.38	0.58	0.39	0.08	0.08	0.03	0.04
Phosphorus (P)								
P_0 - 0 Kg ha^{-1}	4.12	4.61	2.10	2.38	6.42	6.55	5.18	5.29
P_1 - 50 Kg ha^{-1}	5.04	5.21	2.75	2.98	6.62	6.80	5.38	5.52
P_2 - 75 Kg ha^{-1}	5.40	5.72	2.94	3.14	6.73	6.89	5.45	5.57
‘F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m) ±	0.13	0.13	0.20	0.14	0.03	0.03	0.01	0.01
CD at 5%	0.36	0.38	0.58	0.39	0.08	0.08	0.03	0.04
Potassium (K)								
K_0 - 0 Kg ha^{-1}	4.29	4.38	2.15	2.41	5.96	6.09	4.80	4.91
K_1 - 50 Kg ha^{-1}	5.19	5.64	2.89	3.07	6.82	6.99	5.55	5.68

K_2 - 75 Kg ha^{-1}	5.07	5.52	2.75	3.03	7.00	7.16	5.66	5.79
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m) ±	0.13	0.13	0.20	0.14	0.03	0.03	0.01	0.01
CD at 5%	0.36	0.38	0.58	0.39	0.08	0.08	0.03	0.04
Interaction (N X P)								
'F' test	NS	NS	NS	NS	NS	NS	NS	NS
SE(m) ±	0.22	0.23	0.35	0.24	0.05	0.05	0.02	0.03
CD at 5%	-	-	-	-	-	-	-	-
Interaction (N X K)								
'F' test	NS	NS	NS	NS	NS	NS	NS	NS
SE(m) ±	0.22	0.23	0.35	0.24	0.05	0.05	0.02	0.03
CD at 5%	-	-	-	-	-	-	-	-
Interaction (P X K)								
'F' test	NS	NS	NS	NS	NS	NS	NS	NS
SE(m) ±	0.22	0.23	0.35	0.24	0.05	0.05	0.02	0.03
CD at 5%	-	-	-	-	-	-	-	-
Interaction (N X P X K)								
'F' test	NS	NS	NS	NS	NS	NS	NS	NS
SE(m) ±	0.38	0.40	0.61	0.42	0.09	0.08	0.04	0.04
CD at 5%	-	-	-	-	-	-	-	-

Table 2 (a): Effect of nitrogen, phosphorus and potassium levels on yield attributing character of onion

Treatments	Seeds per primary umbel			Seeds per secondary umbel			Seed weight per plant (g)			Seed yield per hectare (q)		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
Nitrogen (N)												
N_0 - 0 Kg ha^{-1}	494.35	529.41	511.88	351.67	371.86	361.77	20.84	21.24	21.04	9.06	9.82	9.44
N_1 - 100 Kg ha^{-1}	616.19	658.68	637.43	451.75	477.73	464.74	24.99	25.55	25.27	12.44	12.70	12.57
N_2 - 150 Kg ha^{-1}	690.31	739.02	713.17	512.51	541.08	526.80	27.47	28.22	27.85	12.76	13.13	12.94
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m) ±	2.29	2.63	2.43	2.17	2.16	2.14	0.08	0.09	0.07	0.02	0.05	0.03
CD at 5%	6.50	7.47	6.89	6.17	6.12	6.07	0.24	0.25	0.21	0.05	0.15	0.08
Phosphorus (P)												
P_0 - 0 Kg ha^{-1}	564.03	603.28	583.66	409.71	432.37	421.04	23.21	23.81	23.51	10.34	11.02	10.68
P_1 - 50 Kg ha^{-1}	607.09	648.02	627.56	443.38	469.01	456.19	24.65	25.15	24.90	11.86	12.20	12.03
P_2 - 75 Kg ha^{-1}	629.73	672.80	651.27	462.84	489.30	476.07	25.44	25.74	25.75	12.08	12.42	12.25
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m) ±	2.29	2.63	2.43	2.17	2.16	2.14	0.08	0.09	0.07	0.02	0.05	0.03
CD at 5%	6.50	7.47	6.89	6.17	6.12	6.07	0.24	0.25	0.21	0.05	0.15	0.08
Potassium (K)												
K_0 - 0 Kg ha^{-1}	549.90	587.38	568.64	397.21	419.34	408.28	22.70	23.14	22.92	10.76	11.31	11.04
K_1 - 50 Kg ha^{-1}	631.35	674.50	652.93	464.18	490.69	477.44	25.50	26.14	25.82	11.86	12.27	12.06
K_2 - 75 Kg ha^{-1}	619.60	662.23	640.91	454.54	480.65	467.59	25.10	25.74	25.42	11.65	12.06	11.86
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m) ±	2.29	2.63	2.43	2.17	2.16	2.14	0.08	0.09	0.07	0.02	0.05	0.03
CD at 5%	6.50	7.47	6.89	6.17	6.12	6.07	0.24	0.25	0.21	0.05	0.15	0.08
Interaction (N X P)												
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m) ±	3.97	4.56	4.21	3.77	3.73	3.70	0.15	0.16	0.12	0.03	0.09	0.05
CD at 5%	11.25	12.94	11.94	10.69	10.60	10.51	0.42	0.44	0.34	0.08	0.26	0.14
Interaction (N X K)												
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m) ±	3.97	4.56	4.21	3.77	3.73	3.70	0.15	0.16	0.12	0.03	0.09	0.05
CD at 5%	11.25	12.94	11.94	10.69	10.60	10.51	0.42	0.44	0.34	0.08	0.26	0.14
Interaction (P X K)												
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m) ±	3.97	4.56	4.21	3.77	3.73	3.70	0.15	0.16	0.12	0.03	0.09	0.05
CD at 5%	11.25	12.94	11.94	10.69	10.60	10.51	0.42	0.44	0.34	0.08	0.26	0.14
Interaction (N X P X K)												
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m) ±	6.87	7.90	7.28	6.52	6.52	6.41	0.25	0.27	0.21	0.05	0.16	0.09
CD at 5%	19.49	22.41	20.67	18.51	18.51	18.20	0.72	0.76	0.59	0.14	0.44	0.25

Table 2(b): Interaction effect between nitrogen and phosphorus levels on number of seeds per primary and secondary umbel

N x P	Seeds per primary umbel									Seeds per secondary umbel								
	2015-16			2016-17			Pooled			2015-16			2016-17			Pooled		
	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2
P_0	459.89	572.84	659.37	492.67	613.44	703.73	476.28	593.14	681.55	325.77	416.21	487.14	341.78	440.68	514.64	333.78	428.44	500.89
P_1	496.74	630.14	694.40	530.55	673.23	740.29	513.65	651.68	717.35	351.09	463.18	515.87	372.80	489.65	544.58	361.94	476.42	530.22
P_2	526.42	645.60	717.16	565.00	689.36	764.04	545.71	667.48	740.60	378.15	475.86	534.53	401.01	502.87	564.03	389.58	489.36	549.28
'F' test	Sig			Sig			Sig			Sig			Sig			Sig		
SE(m) ±	3.97			4.56			4.21			3.77			3.73			3.70		
CD at 5%	11.25			12.94			11.94			10.69			10.60			10.51		

Table 2(c): Interaction effect between nitrogen and potassium levels on number of seeds per primary secondary umbel

N x K	Seeds per primary umbel									Seeds per secondary umbel								
	2015-16			2016-17			Pooled			2015-16			2016-17			Pooled		
	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2
K_0	434.33	553.06	662.32	462.52	592.80	706.81	448.42	572.93	684.57	302.08	400.00	489.56	317.08	423.78	517.16	309.58	411.89	503.36
K_1	509.04	643.97	705.78	546.86	687.67	752.17	527.95	665.82	728.98	363.90	474.52	525.20	386.16	501.48	554.30	375.03	488.00	539.75
K_2	539.69	651.54	702.83	578.85	695.56	749.09	559.27	673.55	725.96	389.03	480.72	522.77	412.36	507.94	551.78	400.69	494.33	537.28
'F' test	Sig			Sig			Sig			Sig			Sig			Sig		
SE(m) ±	3.97			4.56			4.21			3.77			3.73			3.70		
CD at 5%	11.25			12.94			11.94			10.69			10.60			10.51		

Table 2(d): Interaction effect between phosphorus and potassium levels on number of seeds per primary and secondary umbel

P x K	Seeds per primary umbel									Seeds per secondary umbel								
	2015-16			2016-17			Pooled			2015-16			2016-17			Pooled		
	P_0	P_1	P_2	P_0	P_1	P_2	P_0	P_1	P_2	P_0	P_1	P_2	P_0	P_1	P_2	P_0	P_1	P_2
K_0	496.69	574.21	578.81	531.07	611.39	619.67	513.88	592.80	599.24	355.94	414.60	421.10	373.23	439.01	445.79	364.58	426.81	433.44
K_1	592.12	612.39	654.29	633.55	654.71	698.44	612.83	633.55	676.36	432.01	448.63	482.98	457.16	474.48	510.30	444.58	461.56	496.64
K_2	603.30	634.68	656.08	645.22	677.97	700.31	624.26	656.33	678.19	441.17	466.91	484.45	466.71	493.54	511.83	453.94	480.22	498.14
'F' test	Sig			Sig			Sig			Sig			Sig			Sig		
SE(m) ±	3.97			4.56			4.21			3.77			3.73			3.70		
CD at 5%	11.25			12.94			11.94			10.69			10.60			10.51		

Table 2(e): Interaction effect between nitrogen, phosphorus and potassium levels on number of seeds per primary and secondary umbel

N x P x K	Seeds per primary umbel									Seeds per secondary umbel								
	2015-16			2016-17			Pooled			2015-16			2016-17			Pooled		
	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2
P_0K_0	425.87	446.50	617.69	451.37	481.60	660.25	438.62	464.05	638.97	302.20	312.63	452.98	307.95	332.70	479.02	305.08	322.67	466.00
P_0K_1	468.49	630.93	676.92	504.55	674.06	722.05	486.52	652.50	699.48	330.66	463.83	501.53	351.51	490.33	529.64	341.08	477.08	515.58
P_0K_2	485.32	641.08	683.49	522.10	684.66	728.90	503.71	662.87	706.20	344.45	472.16	506.92	365.88	499.01	535.25	355.17	485.58	521.08
P_1K_0	432.51	605.75	684.38	456.56	647.78	729.84	444.54	626.77	707.11	292.96	443.19	507.65	312.20	468.81	536.02	302.58	456.00	521.83
P_1K_1	496.56	641.38	699.21	533.84	684.97	745.31	515.20	663.18	722.26	353.67	472.40	519.81	375.49	499.27	548.69	364.58	485.83	534.25
P_1K_2	561.16	643.28	699.61	601.25	686.94	745.73	581.20	665.11	722.67	406.63	473.95	520.14	430.70	500.88	549.03	418.67	487.42	534.58
P_2K_0	444.61	606.94	684.88	479.62	649.03	730.36	462.12	627.99	707.62	311.08	444.17	508.06	331.09	469.83	536.44	321.08	457.00	522.25
P_2K_1	562.06	659.60	741.21	602.19	703.97	789.15	582.12	681.79	765.18	407.36	487.33	554.25	431.47	514.83	584.59	419.42	501.08	569.42
P_2K_2	572.61	670.25	725.39	613.20	715.09	772.63	592.90	692.67	749.01	416.01	496.07	541.27	440.49	523.93	571.06	428.25	510.00	556.17
'F' test	Sig			Sig			Sig			Sig			Sig			Sig		
SE(m) ±	6.87			7.90			7.28			6.52			6.47			6.41		
CD at 5%	19.49			22.41			20.67			18.51			18.36			18.20		

Table 2(f): Interaction effect between nitrogen and phosphorus levels on seed weight per plant (g) and seed yield per hectare (q)

N x P	Seed weight per plant (g)									Seed yield per hectare (q)								
	2015-16			2016-17			Pooled			2015-16			2016-17			Pooled		
	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2
P_0	19.66	23.54	26.44	20.05	24.07	27.32	19.85	23.80	26.88	7.31	11.70	12.00	8.87	11.86	12.34	8.09	11.78	12.17
P_1	20.88	25.46	27.61	21.27	25.96	28.22	21.08	25.71	27.92	9.66	12.84	13.07	10.00	13.15	13.45	9.83	13.00	13.26
P_2	21.98	25.97	28.37	22.42	26.64	29.13	22.20	26.31	28.75	10.22	12.80	13.22	10.58	13.09	13.60	10.40	12.94	13.41
'F' test	Sig			Sig			Sig			Sig			Sig			Sig		
SE(m) ±	0.15			0.16			0.12			0.03			0.09			0.05		
CD at 5%	0.42			0.44			0.34			0.08			0.26			0.14		

Table 2(g): Interaction effect between nitrogen and potassium levels on seed weight per plant (g) and seed yield per hectare (q)

N x K	Seed weight per plant (g)									Seed yield per hectare (q)								
	2015-16			2016-17			Pooled			2015-16			2016-17			Pooled		
	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2
K_0	18.69	22.88	26.53	19.02	23.30	27.11	18.86	23.09	26.82	7.99	11.93	12.36	9.07	12.19	12.69	8.53	12.06	12.52
K_1	21.40	25.92	27.99	21.86	26.54	28.83	21.63	26.23	28.41	9.55	12.86	13.15	10.12	13.16	13.54	9.83	13.01	13.35
K_2	22.43	26.17	27.89	22.85	26.83	28.74	22.64	26.50	28.31	9.65	12.54	12.77	10.28	12.75	13.16	9.96	12.64	12.96
'F' test	Sig			Sig			Sig			Sig			Sig			Sig		
SE(m) ±	0.15			0.16			0.12			0.03			0.09			0.05		
CD at 5%	0.42			0.44			0.34			0.08			0.26			0.14		

Table 2(h): Interaction effect between phosphorus and potassium levels on seed weight per plant (g) and seed yield per hectare (q)

P x K	Seed weight per plant (g)									Seed yield per hectare (q)								
	2015-16			2016-17			Pooled			2015-16			2016-17			Pooled		
	P_0	P_1	P_2	P_0	P_1	P_2	P_0	P_1	P_2	P_0	P_1	P_2	P_0	P_1	P_2	P_0	P_1	P_2
K_0	20.89	23.47	23.74	21.39	23.80	24.24	21.14	23.64	23.99	9.71	11.36	11.22	10.55	11.75	11.64	10.13	11.55	11.43
K_1	24.18	24.86	26.33	24.82	25.41	27.00	24.50	25.14	26.64	10.62	12.23	12.72	11.21	12.57	13.04	10.92	12.40	12.88
K_2	24.56	25.61	26.27	25.22	26.24	26.96	24.89	25.92	26.63	10.67	11.98	12.30	11.32	12.28	12.59	10.99	12.13	12.44
'F' test	Sig			Sig			Sig			Sig			Sig			Sig		
SE(m) ±	0.15			0.16			0.12			0.03			0.09			0.05		
CD at 5%	0.42			0.44			0.34			0.08			0.26			0.14		

Table 2(i): Interaction effect between nitrogen, phosphorus and potassium levels on seed weight per plant (g) and seed yield per hectare (q)

N x P x K	Seed weight per plant (g)									Seed yield per hectare (q)								
	2015-16			2016-17			Pooled			2015-16			2016-17			Pooled		
	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2
P_0K_0	18.34	19.31	25.04	18.59	19.84	25.74	18.47	19.57	25.39	6.20	11.21	11.73	8.16	11.43	12.05	7.18	11.32	11.89
P_0K_1	20.04	25.48	27.02	20.41	25.99	28.06	20.23	25.74	27.54	7.81	12.14	11.92	9.01	12.38	12.26	8.41	12.26	12.09
P_0K_2	20.61	25.82	27.24	21.13	26.37	28.16	20.87	26.10	27.70	7.93	11.75	12.33	9.45	11.79	12.71	8.69	11.77	12.52
P_1K_0	18.50	24.64	27.27	18.91	24.76	27.73	18.71	24.70	27.50	9.18	12.30	12.59	9.72	12.58	12.95	9.45	12.44	12.77
P_1K_1	20.98	25.83	27.77	21.48	26.42	28.33	21.23	26.13	28.05	9.81	13.23	13.64	10.06	13.62	14.02	9.94	13.42	13.83
P_1K_2	23.15	25.90	27.78	23.43	26.69	28.60	23.29	26.29	28.19	9.99	12.99	12.97	10.23	13.26	13.36	10.11	13.12	13.17
P_2K_0	19.24	24.68	27.29	19.56	25.30	27.84	19.40	24.99	27.57	8.59	12.30	12.76	9.32	12.56	13.06	8.95	12.43	12.91
P_2K_1	23.18	26.44	29.18	23.69	27.20	30.11	23.43	26.82	29.64	11.04	13.22	13.89	11.28	13.49	14.34	11.16	13.36	14.12
P_2K_2	23.53	26.80	28.65	24.00	27.42	29.45	23.76	27.11	29.05	11.02	12.87	13.00	11.16	13.21	13.41	11.09	13.04	13.20
'F' test	Sig			Sig			Sig			Sig			Sig			Sig		
SE(m) ±	0.25			0.27			0.21			0.05			0.16			0.09		
CD at 5%	0.72			0.76			0.59			0.14			0.45			0.25		

Conclusion
The maximum seed yield of onion (14.12 q ha^{-1}) was produced by the combine application of nitrogen (150 kg ha^{-1}), phosphorus (75 kg ha^{-1}) and potassium (50 kg ha^{-1}) (i.e. $N_2P_2K_1$) as compared to rest of the treatment combination.

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