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Effect of nitrogen level and spacing on growth, yield and quality of kharif onion (*Allium cepa* L.) Cv. N-53”

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Abstract
A field experiment was conducted during summer rain (kharif) season of 2017-2018 at research instructional farm, AKS University Sherganj Satna Madhya Pradesh. An experiment was entitled “Effect of nitrogen level and spacing on growth, yield and quality of kharif onion (*Allium cepa* L.) Cv. N-53”. The experiment consisting of twelve treatments with plant spacing as well as nitrogen level (0, 40, 80 and 120kg/ha. was laid out in Randomize Block Design with three replication. Growth parameter different significantly at all stage of crop growth were maximum plant height (22.73, 48.81 and 60.31cm) at 30, 60 DAT at harvest and number of leaves (8.03, 10.89 and 13.51) 30, 60 DAT and at harvest were recorded in the 120kg /nitrogen. Thickness of neck, Fresh weight, Dry weight of leaves and yield attributes viz., Bulb diameter, height of bulb, fresh weight of bulb, dry weight of bulb & total yield (g) plots, TSS and quality of onion are significant. The both factors nitrogen and spacing of onion (120kg/N_3 and 15x20cm) S_3 were significant. It was observed that spacing’s *i.e.*, 15x20cm significantly improved growth and yield of onion.

Keywords: Onion (*Allium cepa* L.) Nitrogen level, spacing, growth, yield and quality.

Introduction

Onion (*Allium cepa* L.) belongs to family Liliaceae, is of great importance due to its medicinal and dietic values. Onion is considered to be the second most important vegetable crop grown in the world after tomato. It is an indispensable item in every kitchen as vegetable and condiment used to flavor many of the food stuffs. Therefore, onion is popularly referred as “Queen of Kitchen”. Onion is extremely important vegetable crop not only for internal consumption but also as highest foreign exchange earner among the fruits and vegetables. The export of onion during 2011 -12 was 13,09,863.26 thousand tons with a value of Rs 1,722.85 crores (NHB, 2011) [3]. Onion requires adequate soil moisture due to the relatively short and small root system. Onions are sensitive to photoperiod. Long days are favorable to onion production as this enhances leaf development and formation which, in turn, is directly related to bulb size. India is the 2nd largest producer of onion, in the world next only to China but the productivity of onion in India is very low i.e. 14.21 tons/ ha as compared to China and other countries like, Egypt, Netherlands, & Iran etc. The area under onion cultivation in India is about 11.81 lakh ha with production of 18.92 million tons (NHB, 2015) [5] of onion annually of which 50 percent comes from rabi onion harvested in April-May, 30 percent from late kharif harvested in January-February and 20 percent from kharif onion harvested in October-November. The use of appropriate agronomic management has an undoubted contribution in increasing crop yield. One of the important measures to be taken in increasing the productivity of onion is to determine the optimum amount of fertilizers rates and spacing in each agro-ecology. However, the crop response to fertilizer and spacing vary with different agro-climatic condition. Among the fertilizers, Nitrogen plays a vital role and readily available plant nutrient of the major elements in growth and development of plant. Nitrogen primarily encourage vegetative growth and to impart a deep green colour to the leaves. It is an essential constituent of protein and chlorophyll. In addition, nitrogen is present in many other compounds which are of great physiological importance in metabolism, such as alkaloids, the nucleotides as well as in many enzymes and vitamins. It is thus a basic constituent for “life”. All vital process is associated with the presence of a functionally reactive plasma in the protein of which nitrogen is present as a characteristic constituent It improves quality and succulence of leafy vegetables their by increasing protein content of food. Apart from the vertical selection, the chief consideration for increasing the yield is plant population and plant geometry. Nitrogen fertilization plays an important role to reach the optimum yield potential. Nitrogen is essential to increase the bulb size and yield but excessively high doses of nitrogen cause delay in bulb maturity. Khan *et al.* (2002) [2] reported a significant effect of all the growth and yield components of onion and larger percentage of small and medium bulbs were obtained in the narrowest spacing. Spacing also affects growth yield and quality of onion bulb. If spacing are narrowed the growth and bulbs yield reduced, besides quality of bulbs that also deteriorates much work done on plant density also showed a paramount influence on growth on yield of onion and it has been reported that when onion plants were planted by observers 20×10 cm spacing maximum growth and bulb yields were obtained. Different factors affect the successful production of onion crop but plant spacing is the most important factors for vegetative growth and plant population per unit area is also important and responsible for increasing the yield and quality of bulb per unit area.

Materials and Methods

The present investigation entitled "Effect of nitrogen level and spacing on growth, yield and quality of kharif onion (*Allium cepa* L.) CV. N-53" was conducted to explore the production potential of onion in the region. The experiment was arranged in a factorial randomized block design with 12 treatments splitted in two factorials i.e., four levels of Nitrogen and three plant spacing with 3 replications. The randomized of the treatment was done with the help of random number are fallows;

Design: Randomized block design (in factorial concept)
Replication: 03
Treatment: 12
Total No. of plots: 36
Distance between replications: 1.0 m
Distance between plots: 0.5 m
Distance between row to row: 15
Distance between plant to plant: 3 (10, 15 & 20 cm)
Nitrogen level: 4 (0, 40, 80 and 120 kg/ha)
Net experimental area: 2 x 3 m

Details of Treatments

Factor – A

(Four levels of nitrogen) - Treatment symbol
0 Kg/ha - N_0
40 kg/ha - N_1
80 kg/ha - N_2
120 kg/ha - N_3

Factor – B

(Three plant spacing) - Notations
15 x 10 cm - S_1
15 x 15 cm - S_2
15 x 20 cm - S_3

Observation assessments; (A) Growth parameter:

(i) Plant height (cm): The height measured from the base to the longest green leaf of the plant in centimeters. The mean plant height was recorded at 30, 60 DAT and at harvest stage.

(ii) Numbers of leaves per plant: Leaves of lifted plants were counted from each plot and the mean was recorded at 30, 60 DAT and at harvest stage.

(iii) Thickness of neck (cm): From lifted plant of onion of bulb was measured with help of Vernier calipers and mean diameter was recorded stage wise.

(iv) Fresh weight of plant (g): For determining fresh weight of plant at schedule intervals, five plants were randomly selected and uproot from each plot from the adjoining observation in each plot and weight of fresh plant were undertaken.

(v) Dry weight of plant (g): For determining dry weight of different plant part at scheduled intervals, five plants were randomly selected and uproot from each plot from the adjoining observation rows in each plot. The components of plant were initially sun dried and then dried in oven at 60^0C to obtain weight of the samples.

(B) Yield parameter; (i)Bulb diameter(cm): The diameter of five bulbs taken from each treatment was measured by means of Vernier caliper sand the mean was recorded at 30, 60 DAT and at harvest.

(ii) Height of bulb: The Height of bulbs were counted from the 5 tagged plant in each plot and the average was worked out.

(iii) Fresh weight of bulb (g): The bulb fresh weight was taken after the harvest, by taking 5 bulbs from each treatment. The average bulb weight was calculated and recorded.

(iv) Dry weight of bulb (g): The dried weight of bulb was taken after the harvesting and curing, by taking 5 bulbs from each treatment. The average bulb weight was calculated and recorded.

(v) Total yield (kg/plot): The total number of bulbs were weighted in kg from each plot under different treatment the average of observation recorded was taken as yield quintal per hectare.

(C) Quality; (i)T.S.S.: The percentage of T.S.S. content in the juice of the onion bulb of different treatments was recorded with the help of Pocket Refract meter (Digital).

Results; (A) Growth parameter:

Plant height at 30 DAT(cm): Data with regards to mean plant height at 30 DAT is indicated that there was a significant increase in the height as the levels of nitrogen were increased. The tallest plant of 22.73cm was recorded with 120 kg N/ha (N_3) followed by 80 kg N/ha and superior to all other treatments, whereas the minimum height (14.58 cm) was recorded with 0 kg N /ha (N_0). The plant spacing also significantly influenced the plant height. maximum plant height (19.48cm) was found under 15x20 cm (S_3) spacing followed by 15x15 cm (18.69cm) there was a significant increase in height was recorded of wider spacing 15x20 (S_3) and minimum plant height (17.75cm) was recorded of closer spacing 15x10 (S_1).

Plant height at 60 DAT(cm): Application of increasing doses of nitrogen(0, 40, 80 and 120 kg/ha) enhanced the plant height significantly up to 120 kg N/ha. at 60 DAT growth stages. The tallest plant of 48.81cm was recorded with 120 kg N/ha (N_3) followed by 80 kg N/ha and superior to all other treatments, whereas the minimum height (40.92cm) was recorded with 0 kg N /ha (N_0). The plant spacing also significantly influenced the plant height. maximum plant height (45.80cm) was found under 15x20 cm (S_3) spacing followed by 15x15 cm (44.82cm) there was a significant increase in height was recorded of wider spacing 15x 20 (S_3) and minimum plant height (43.86cm) was recorded of closer spacing 15x10 (S_1).

Plant height at harvesting stage (cm): Data with regards to mean plant height at harvest stage is indicated that there was a significant increase in the height as the levels of nitrogen was increased. The tallest plant of 60.31cm was recorded with 120 kg N/ha (N_3) followed by 80 kg N/ha and superior to all other treatments, whereas the minimum height (52.56cm) was recorded with 0 kg N /ha (N_0). The plant spacing also significantly influenced the plant height. Maximum plant height (57.34cm) was found under 15x20 cm (S_3) spacing followed by 15x15 cm (55.65cm) and m closer spacing 15x10 (S_1).

No. of leaves at 30 DAT: The data indicated that was significant increase in number of leaves at 30 DAT as the levels of nitrogen increased. The maximum number of leaves (8.03) was recorded with 120 kg N/ha (N_3) followed by 80 kg N/ha (N_2) which were superior to all other treatments, whereas the minimum number of leaves (5.07) was recorded with 0 kg N/ha (N_0). The spacing also significantly influenced the number of leaves. Maximum number of leaves (7.07) was recorded with 15x20 cm (S_3) followed by 6.65 with 15x15 cm (S_2) there was a significant increase in the number of leaves as the spacing was recorded at a wider spacing of 15x20 cm (S_3), whereas the minimum number of leaves (6.38) was recorded with 15x10 cm (S_1).

No. of leaves at 60 DAT: Application of increasing doses of nitrogen (0, 40, 80 and 120 kg/ha) enhanced the number of leaves significantly up to 120 kg N/ha at 60 DAT growth stages. The maximum number of leaves of 10.89 was recorded with 120 kg N/ha (N_3) followed by 80 kg N/ha and superior to all other treatments, whereas the minimum number of leaves (7.23) was recorded with 0 kg N /ha (N_0). The plant spacing also significantly influenced the number of leaves. Maximum number of leaves (9.23) was found under 15x20 cm (S_3) spacing followed by 15x15 cm (8.92) there was a significant increase in number of leaves was recorded of wider spacing 15x 20 (S_3)and minimum number of leaves(8.54) was recorded of closer spacing 15x10 (S_1).

No. of leaves at harvest: Data with regards to mean number of leaves at harvest stage is indicated that there was a significant increase in the number of leaves as the levels of nitrogen was increased. The maximum number of leaves of 13.51 cm was recorded with 120 kg N/ha (N_3) followed by 80 kg N/ha and superior to all other treatments, whereas the minimum number of leaves (11.50) was recorded with 0 kg N /ha (N_0). The plant spacing also significantly influenced the number of leaves maximum number of leaves (12.86) was found under 15x20 cm (S_3) spacing followed by 15x15 cm (12.58), whereas the minimum number of leaves (12.33) was recorded with spacing level of 15x10 cm (S_1).

Thickness of neck at 30 DAT (cm): The effect of interaction between nitrogen and plant spacing was found to be significant for variation in thickness of neck. The treatment combination consisting of 120 kg N/ha + 15x20 cm (N_3S_3) produced significantly maximum thickness of neck (0.98 cm) followed by 120 kg N/ha + 15x15 cm (N_3S_2, 0.97cm) as compared to all the remaining treatment combinations. The lowest neck thickness (0.71 cm) was noticed under 0 kg N/ha + 15x10 cm (N_0S_1) treatment combination. The data indicated that nitrogen and plant spacing was not found significant for this growth parameter at 30 DAT stage of the crop growth period.

Thickness of neck at 60 DAT(cm): The effect of interaction between nitrogen and plant spacing was found to be significant for variation in thickness of neck. The treatment combination consisting of 120 kg N/ha + 15x20 cm (N_3S_3) produced significantly maximum thickness of neck (1.55 cm) followed by 120 kg N/ha + 15x15 cm (N_3S_2, 1.49cm) as compared to all the remaining treatment combinations. The lowest neck thickness (1.16 cm) was noticed under 0 kg N/ha + 15x10 cm (N_0S_1) treatment combination. The data indicated that nitrogen and plant spacing was not found significant for this growth parameter at 60 DAT stage of the crop growth period.

Thickness of neck at harvest (cm): The effect of interaction between nitrogen and plant spacing was found to be significant for variation in thickness of neck. The treatment combination consisting of 120 kg N/ha + 15x20 cm (N_3S_3) produced significantly maximum thickness of neck (1.75cm) followed by 120 kg N/ha + 15x15 cm (N_3S_2, 1.74 cm) as compared to all the remaining treatment combinations. The lowest neck thickness (1.55cm) was noticed under 0 kg N/ha + 15x10 cm (N_0S_1) treatment combination.

Fresh weight of plant (g): The increasing N levels from zero to 120 kg/ha resulted in significant increase in this parameter. Accordingly, the maximum fresh weight 71.22g was recorded in case of N-120 kg/ha (N_3) followed by 80 kg N/ha (N_2) and superior to all other treatments, whereas significantly lowest value (57.67 g) was obtained from zero level of nitrogen (N_0).

Dry weight of plant (g): The highest dose of nitrogen, i.e. 120 kg/ha (N_3), was found annexed with the maximum dry weight per-plant (42.67 g). This value had significant edge over the dry weight per plant noted at 0, 40 and 80 kg N/ha. Furthermore, lower doses of nitrogen i.e.80 and 40kg/ha were also found significantly superior (38.78 and 36.00 g, respectively) over 0 kg N/ha (N_0). The dry weight per plant showed significant response to varied levels of spacing. Thus, the maximum dry weight of plant was 38.50g in case of widest 15x20 (S_3) cm spacing which resulted in significantly higher dry weight over the remaining treatments.

(B)Yield parameter:

Bulb diameter (cm): The higher bulb diameter (5.04 cm) was recorded when nitrogen was supplied to onion with 120 kg/ha (N_3). Application of different doses of nitrogen significantly influenced the bulb diameter onion. The minimum bulb diameter (2.52 cm) was observed due to application of 0 kg/ha nitrogen (N_0). The plant spacing also significantly influenced the bulb diameter. Maximum bulb diameter (4.05 cm) was found under 15x20 cm (S_3) spacing followed by 15x15 cm (S_2, 3.69 cm) there was a significant increase in bulb diameter was recorded of wider spacing with 15x 20 (S_3) and minimum bulb diameter (3.69 cm) was observed due to closer spacing15x10 (S_1).

Height of bulb (cm): The maximum height of bulb of 9.74cm was recorded with 120 kg N/ha (N_3) followed by 80 kg N/ha and superior to all other treatments, whereas the minimum height of bulb (7.22cm) was recorded with 0 kg N /ha (N_0). The plant spacing also significantly influenced the height of bulb. Maximum height of bulb (8.60cm) was found under 15x20 cm (S_3) spacing followed by 15x15 cm (8.45 cm).

Fresh weight of bulb (g); The maximum fresh weight of bulb of 77.89g was recorded with application of 120 kg N/ha (N_3) followed by 80 kg N/ha and superior to all other treatments, whereas the minimum fresh weight of bulb (62.11g) was recorded with 0 kg N /ha (N_0). The plant spacing also significantly influenced the fresh weight of bulb. Maximum fresh weight of bulb (71.50g) was found under wider spacing of 15x20 cm (S_3) followed by 15x15 cm (S_2, 70.75g) spacing and minimum fresh weight of bulb (69.50g) was observed due to closer spacing with 15x10 (S_1).

Dry weight of bulb (g): The maximum dry weight of bulb of 71.44 g was recorded with application of 120 kg N/ha (N_3) followed by 80 kg N/ha and superior to all other treatments, whereas the minimum dry weight of bulb (45.67 g) was recorded with 0 kg N /ha (N_0). The plant spacing also significantly influenced the dry weight of bulb. Maximum dry weight of bulb (61.50 g) was found under wider spacing of 15x20 cm (S_3) followed by 15x15 cm (S_2, 59.50 g) spacing and minimum dry weight of bulb (56.08 g) was observed due to closer spacing with 15x10 (S_1).

Total bulb yield (kg/plot): Data indicated that there were significant differences in bulb yield per plot for the nitrogen levels and maximum bulb yield per plot was recorded under 120 kg N/ha (N_3, 16.68 kg) followed by 80 kg N/ha (N_2, 15.62 kg). The minimum bulb yield per plot 12.08 kg was found with 0 kg N/ha (N_0). With regard to different spacing's the maximum bulb yield per plot 17.68 kg was found under 15x10 cm (S_1) of closer spacing followed by 15x15 cm (S_2, 14.35kg). These two spacing (S_1&S_2) were significantly superior to the S_3, (15x20cm) level of spacing's which gave the lowest bulb yield per plot of 12.00 kg.

(C) Quality parameters:

T.S.S. (%); Analysis of TSS data indicated that the TSS content of onion bulb was varying from 12.40 to 9.71 percent. Data indicated that there were significant differences in TSS content for the nitrogen levels and maximum TSS content was recorded under 120 kg N/ha (N_3, 12.40 percent) followed by 80 kg N/ha (N_2, 12.08 percent). The minimum TSS content9.71percent was found with 0 kg N/ha (N_0).

Discussion

Influence of growth parameters: The comparison of various growth parameters also revealed that increasing levels of nitrogen up to120kg/ha were found to increase plant growth significantly. Thus, there was linear rise in the vegetative growth of onion plants with the increasing dose of nitrogen. As such the maximum plant growth was recorded at the highest level of nitrogen i.e. 120kg/ha. The effect of nitrogen in the improvement of plant growth can be explained by the fact that nitrogen being the improvement constituent of chlorophyll, amino acids, proteins, nucleic acid also influences cell multiplication and cell elongation which ultimately accelerates the vegetative growth (Singh *et al*., 2004).

Influence on yield attributes: These parameters are also responsible for the yield of bulb per plot and per hectare. The highest diameter of bulb, height of bulb and weight of bulb was annexed with 120 kg, N + 15x20 cm which was significantly more than rest of the treatments. The larger bulb size (bulb-diameter), height of bulb and weight of bulb with application of higher level of nitrogen may be attributed to better partitioning efficiency of the treatments to the sink. These results are in general agreement with the results of Banafer and Gupta (2005) also found highest onion bulb size with the application of 100 kg N + 60 kg P20s + 100 kg K_2O/ha in conjunction with 10 t FYM or 10t poultry manure/ha.

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