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To study the interactive effect of age of seedling and plant spacing on growth and yield of onion bulb (*Allium cepa* L.) Cv. Pusa Red

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Abstract
A field experiment "To study the interactive effect of age of seedling and plant spacing on growth and yield of onion bulb (*Allium cepa* L.) Cv. Pusa Red'' was conducted at the experimental field of AKS University, Satna, Horticulture research farm, during the period October 2016 to March 2017. This growth observations was significantly influence by the age of seedlings, 45 days old seedlings brought about significantly higher plant height (44.92 cm), number of leaves (8.74), length of leaves (42.68 cm), width of leaves (1.29 cm), fresh weight of leaves (97.71 g), dry weight of leaves (21.20 g), fresh weight of bulb (99.89 g), diameter of bulb (6.67 cm) and bulb yield (290.47 q/ha) as compared to 25 and 35-days old age of seedlings. The increase in plant density up to 20x20 cm resulted in significantly higher plant height (42.58 cm), number of leaves (7.84), length of leaves (40.38 cm), width of leaves (1.07 cm), fresh weight of leaves (83.34 g), dry weight of leaves (16.79 g), fresh weight of bulb (81.41 g), diameter of bulb (5.53 cm), bulb yield (274.40 q/ha) as compared to closer 20x15 and 20x10 cm density.

Keywords: Onion (*Allium cepa* L.), age of seedling, plant spacing, growth and yield

Introduction
Onion (*Allium cepa* L.) is one of the important vegetable crop of Amaryllidaceae (Alliaceae) Family, which have got 2n=16 chromosome number. India is the second largest producer of onion in the world and occupies 1203.6 lac ha area, with production of 19401.7 metric tonnes, and productivity of 16.1metric tonnes/ha. Gujarat is the leading state in productivity i.e. 25.4 metric tonnes/ha followed by Bihar, Haryana and Andhra Pradesh. In Madhya Pradesh, area under onion crop is 257.6 hectares with production of 5807.8 Mt. 2013-14. The important onion growing districts in Madhya Pradesh are Damoh, Katni, Bhind, Burhanpur, Balaghat and Khandwa. (H. S. at a Glance, 2015) [3]. Onion is physiologically a long-day plant for bulbing and generally planted during Rabi season under temperate conditions. The production and quality of onion bulb is affected by many factors like varieties, sowing and transplanting date, plant geometry, nutrition, irrigations, cultural practices etc. Among them sowing and transplanting time is one of the most important factors with greatly influence the growth and yield of onion. The optimum time of sowing is generally governed by climate of region particularly temperature and photoperiods. The density between plants is one of the important factors which ultimately affects nutrients uptake, growth and yield of plants. Increase in plant spacing, the total plant population/ha decreases, but with more nutrition, the individual plant grows better and yields more and vice-versa. The increase or decrease of plant population/ha had a definite pattern relation to the crop yield (Vaisnava, 2012) [9]. Different factors affect the successful production of onion crop but age of seedling is the main 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. The higher yield and better control of over or under bulb size could be obtained if plants are grown at optimum age of seedling. Bulb neck diameter, mean bulb weight and plant height decreased as age of seedling decreased. Total bulb yield can be increased as age of seedling increases (Kanton *et al.* 2002). The yield reduction due to increasing the age of nursery plant may, however, be compensated with manipulation of planting density in onion. It could be attributed to the lack of adaptation of

proper planting density and cultivated of unsuitable varieties for the specific locality. Planting density greatly influenced quality, texture, taste and yield of onion even within a particular variety. The production of onion is influenced by a large number of agronomic practices such as, time and period of planting, planting density, age of seedling and judicious use of fertilizer application. Among the plant density the age of seedlings caused paramount influence in pushing-up the production of onion crop. Further it has also been noticed that density of planting affects seriously to growth and other yield attributing characters (Maurya and Singh, 1997) [5].

Materials and Methods

The present investigation was carried out on well pulverized field of the experimental farm of Horticulture, AKS University, Satna (M.P.). The field experiment was conducted during *rabi* (winter) season of 2016-17. The experiment was conducted at the instructional farm of Horticulture, AKS University, Satna M.P. The experimental site is situated at the latitude of $23^0$58 North and east longitude of $80^0$81. The experimental plot was located about 500 meters South of AKS University, Campus. The experimental details are as fallow – Design - RBD (with Factorial concept), Replications – 03**,** Treatment combination – 09, Total No. of plots – 27, Plot size (meter) - 3.0 x 5.0 m^2, Distance between replications - 0.75 m, Distance between plots - 0.5 m, Distance between row to plant, 20 cm x 10, 15& 20 cm and Net experimental area - 405 m^2 etc.

Details of Treatments

Factor – A (Age of seedling treatment)		Symbol
25 day	-	A_1
35 day	-	A_2
45 day	-	A_3

Factor – B (Three plant density)		Notations
20 x 10 cm.	-	D_1
20 x 15 cm.	-	D_2
20 x 20 cm.	-	D_3

Treatment combinations

T_1= A_1D_1	T_2= A_1D_2	T_3= A_1D_3
T_4= A_2D_1	T_5= A_2D_2	T_6= A_2D_3
T_7= A_3D_1	T_8= A_3D_2	T_9 = A_3D_3

(A) Pre harvest observations

(i) Height of the plant (cm): The plant height was measured from the base to the longest green leaf of the plant in centimeters. The mean plant height was recorded at 30, 60 and 120 days after planting under each treatment.

(ii) Numbers of leaves per plant: The leaves of per plants were counted from each plot and the mean was recorded at 30, 60, and 120 days after planting under each treatment.

(iii) Length of leaves per plant (cm): The length of leaves was measured from the base to the longest green leaf of the plant in centimeters. The mean length of leaves was recorded at 30, 60 and 120 days after planting under each treatment.

(iv) Width of leaves per plant (cm): The width of leaves was measured from the base on green leaf of the plant in centimeters. The mean width of leaves was recorded at 30, 60 and 120 days after planting under each treatment.

(B) Post harvest observations

(i) Width of neck (cm): From lifted plant of onion of bulb was measured with help of vernier calipers and mean width of neck was recorded at the time of harvesting.

(ii) Fresh weight of leaves per plant (g): For determining fresh weight of leaves of different 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 leaves were undertaken.

(iii) Dry weight of leaves per plant (g): Fresh leaves of 100 g. as per treatment sample were weighted and cut into small pieces. After drying for samples were oven dried at 72 hours.

(iv) Fresh weight of bulbs (g): The average fresh weight of five bulbs just after harvest was recorded under each treatment.

(v) Diameter of bulbs (cm): The diameter of five bulbs was measured from each treatment by means of vernier calipers and the mean was recorded.

(vi) Yield of bulb per hectare (q): The total yield per plot at the tagged plant was calculated and converted into q/ha.

Results

Growth characters; Plant height (cm): The data on plant height recorded different stages are highlighted in table 1.0**.** The treatment interactions were found to be significant only at 60 DAT stage.

Table 1: Plant height (cm) of onion at 30, 60 DAT and at harvest (120 DAT) as influenced by age of seedling and plant density

Treatments	Plant height (cm)		
Plant density (cm)	**30 DAT**	**60 DAT**	**At harvest**
20x10	17.11	26.47	39.80
20x15	18.64	28.31	41.40
20x20	20.51	29.27	42.58
S.E.m ±	**0.31**	**0.26**	**0.35**
CD(P=0.05)	**0.94**	**0.78**	**1.05**
Age of seedlings			
25days	13.91	24.78	37.71
35days	18.09	27.27	41.24
45days	24.26	32.00	44.92
S.E.m ±	**0.31**	**0.26**	**0.35**
CD(P=0.05)	**0.94**	**0.78**	**1.05**
Interaction	**NS**	**Sig.**	**NS**

Number of leaves/plant: The data pertaining to this parameter recorded at different growth stages are depicted in the treatment interactions, although non-significant the maximum leaves count was observer under widest plants density (20x20 cm) with latest (45 days) old seedlings. In contrast the minimum leaves count was notes under closest plants density (20x10 cm) with earliest age seedlings (25 days) at every stage of observations.

Length of leaves/plant (cm): The treatment interactions were found to be significant only at 60 DAT stage. However the overall trend indicate that the widest plant spacing (20x20 cm) with 45-days old seedlings performer the best. Whereas the closer spacing's with earlier age seedlings tended to decrease this parameter. Accordingly the lowest length of leaves was noted from 20x10cm density with 25-days old seedlings at every stage.

Average width of leaves/plant (cm): The treatment interactions were found to be significant at 30 DAT and at harvest stages. The leaves width was found significantly

highest (0.54 cm at 30 DAT and 1.57 cm at harvest) as compared to the remaining interactions. On the other hand, the significantly lowest leaves width (0.33 cm at 30 DAT and 0.74 cm at harvest) was found in case of closest plant density (20x10 cm) with earliest 25 days age of seedlings. The results trend at 60 DAT stage was also the same.

Yield Attributes; Fresh weight of leaves at harvest (g): The non-significantly maximum fresh weight (23.68g) was noted from (20x20 cm) with 45-days old seedlings. Whereas the non-significantly lowest fresh weight (10.22g) was noted from 20x10 cm with 25-days old seedlings.

Dry weight of leaves/plant (g): The treatment interactions although, non-significant, the maximum dry weight up to 23.68g/plant was recorded from 20x20 cm spacing with 45-days old seedlings. This parameter tended to decrease continuously with the decrease in plant densities with the decreased age of seedlings. Accordingly the lowest dry weight (10.22g/plant) was obtained from 20x10 cm spacing with 25-days old seedlings.

Width of neck (cm): The treatment interactions although non-significant, the maximum width of neck (2.49 cm) was noted from 20x20 cm with 45-days old seedlings. On the other hand, only 1.53 cm value was noted from 20x10 cm with 25-days old seedlings.

Fresh weight of bulb (g): The treatment interactions, 20x20 cm plant density with 45-days old seedlings performed the best, the significantly maximum fresh weight was 109.62g. This was significantly superior to rest of the interactions. Whereas the significantly lowest fresh weight (43.87g) was noted from 20x10 cm density with 25-days old seedlings.

Diameter of bulb (cm): The treatment interactions, although non-significant, 20x20 cm spacing with 45-days old seedlings recorded highest bulb diameter (7.19 cm). In contrast the lowest value (3.08 cm) was noted from 20x10 cm spacing with 25-days old seedlings.

Bulb yield/ha (q): The data presented in the treatment interactions, although non-significant, the increased plant density up to 20x20 cm with 45-days increased age of seedling resulted in the lowest bulb yield (245.85 q/ha). On the other hand, 20x20 cm density with 45-days old seedlings gave the highest bulb yield (294.45 q/ha).

Discussion; and Summary Morphological growth parameters: The periodical observations recorded on onion var. Pusa Red indicated that the plant height, number of leaves/plant, length of leaves, width of leaves, fresh and dry weight of leaves/plant were enhanced significantly with the increased plant density up to 20x20 cm. At harvest stage, the significantly maximum plants height was 42.58 cm, number of leaves 7.84/plant, length of leaves 40.38 cm, width of leaves 1.07 cm, fresh weight of leaves 83.34 g and dry weight of leaves 16.79 g. The significantly higher growth parameters under widest plant density (20x20 cm) may be as inbred to the fact that the wider spacing. between plants provider less competition among the plants or most favorable conditions viz. increased space between rows, enough supply of nutrients and soil moisture and increate inter caption of solar radiation essential for the actively growing plants. In the present findings, number of leaves and leaves area/plant were enhanced significantly due to wider spacing's. These functional leaves and photosynthesizing area increased the photosynthesizing that to encourage growth parameters of onion. The present findings corroborate with those of many researches (Dereje *et al.*, 2012 and Muhammad *et al*., 2015) [2, 6]. Amongst the age of seedlings, 45-days old seedlings at harvest stage brought about significantly higher plant height 44.92 cm, number of leaves 8.74/plant, length of leaves 42.68 cm, width of leaves 1.29 cm, fresh weight of leaves 97.71g and dry weight of leaves 21.20g. The significantly higher growth parameters under transplanting of 45-days old seedlings may be owing to the fact that under favorable temperature, the transplanting of 45-days older seedlings performer active growth which might have contributed to more vigorous growth and development of plants and thus improvements in the pseudo stem. These results are in consonance with those of other workers (Jung Soo *et al.*, 2000; and Singh *et al.*, 2016) [4, 8].

Yield-attributing parameters: The data summarized that the higher plant density (20x20 cm) brought about significantly higher fresh weight and diameter of bulb (81.41 g and 5.53 cm) as compared to the lower plant densities (20x10 and 20x15 cm). On the other hand, the fresh weight and diameter of bulb was significantly lowest (67.17 and 4.66 cm, respectively).The maximum increase in yield-attributes under 20x20 cm (widest) plant spacing might be as a results of maximum inverse in the growth parameters, where in wider spacing provider increase space between plants, sufficient sunlight, nutrients and soil moisture for better plants growth. The present findings are in consonance with those of many research with those of many research workers (Patel, 2008). The transplanting 45-days old seedlings resulted in significantly higher fresh weight of bulb (99.89 g) as well as diameter of bulb (6.67 cm) in comparison to the transplanting of 25 and 35 days old seedlings. This may be absorbed to the fact that 45-days old seedlings synthesized much more photosynthesis which translocated towards the reproductive organs (bulbs). The similar results have also been obtained by Bhonde *et al.*, 2001) [1]

Productivity parameters: The treatments comprised three plant densities (20x10, 20x15 and 20x20 cm) and threse age of seedlings for transplanting (25, 35 and 45-days). Thus the nine treatment combinations were laid out in the field in a factorial randomized block design keeping three replications. Onion var. Pusa Red was transplanted on 18 Nov; 28 Nov; and 8 Dec. uniform does of FYM @ 20 t/ha along with 50 kg P_2O_5 and 60 kg K_2O was applied as basal in all the treatments. The crop was grown as per recommended package of practices.

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