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BC Das
Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

P Tripathy
Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

GS Sahu
Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

AK Das
Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

SK Swain
Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

P Mandal
Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

S Mohanty
Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

D Sahoo
Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

Corresponding Author:
BC Das
Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

Effect of planting dates and varieties on seed yielding attributes of onion (*Allium cepa* Linn.) under west central table land zone of Odisha

BC Das, P Tripathy, GS Sahu, AK Das, SK Swain, P Mandal, S Mohanty and D Sahoo

Abstract
Odisha produces about 419.09 thousand MT of onion from an area of 34.92 thousand hectares with a productivity of 120q/ha. Out of thirty districts, the major onion producing districts of Odisha are Kalahandi, Bolangir, Bargarh, Nuapada, Sambalpur, Ganjam, Angul, Deogarh and Boudh that comes under west central table land zone. Despite increase in areas, the productivity of onion is much lower due to limited availability of quality seeds in inadequate quantities suitable to locality and associated production technologies used, among the farmers. India needs around 9400 tons of onion seed annually for covering 14.30 lakh hectares area. Besides selection of suitable varieties, appropriate time of planting is also one of the important factors, which influences the growth, yield and quality of crop and thereby influencing seed yield. So, planting at different times is considered to test the suitable dates for quality seed production. Hence, the present investigation was taken up during the late *kharif* season of 2014-15 and 2015-16 in the experimental plot of College of Horticulture, Odisha University of Agriculture and Technology, Sambalpur, Odisha to find out suitable time of planting and varieties in split plot design for production of quality seeds with good seed yielding attributes. Onion planting on 25th September showed better performance with respect to seed yield attributing characters such as number of seed stalks per plant (3.05), length of scape (66.11 cm), diameter of scape (1.41 cm), diameter of umbel (5.35 cm), height of umbel (4.09 cm) etc. and was statistically superior to other treatments. The seed yield attributing characters helped to increase the total seed yield to 249.43 kg/ha at 25th September planting. Among the onion varieties Arka Niketan was significantly superior than other varieties tested and performed well with respect to seed yield attributing characters like, number of seed stalks per plant (3.18), diameter of umbel (4.59 cm), Days to seed maturity after bolting (61.17) etc. and gave the highest total seed yield of 214.7 kg/ha.

Keywords: Onion, planting date, variety, umbel growth, scape growth, total seed yield

Introduction
Onion (*Allium cepa* Linn.) is one of the most important and oldest vegetable crops known to mankind and an integral component of culinary preparations all over the worldwide. It is grown as an annual for bulb production and biennial for seed production. It is also called as "Queen of Kitchen" (Selvaraj, 1976) [15].

The outstanding characteristic of onion is its pungency, which is due to a volatile compound "Allyl-propyl-disulphide" ($C_6H_{12}S_2$). The mature bulb contains some starch, appreciable quantities of sugars, some protein, and vitamins A, B, and C (Elhag and Osman, 2013) [13]. It is also one of the richest sources of flavonoid in the human diet. Intake of flavonoid reduces risk of cancer, heart disease and diabetes. Onion is also well known for anti-bacterial, anti-viral, anti-allergenic and anti-inflammatory and preservative action.

Odisha produces about 419.09 thousand MT of onion from an area of 34.92 thousand hectares with a productivity of 120q/ha (Mohanty, 2015) [8] and the major onion producing districts of Odisha are Kalahandi, Bolangir, Bargarh, Nuapada, Sambalpur, Ganjam, Angul, Deogarh and Boudh (Sahoo *et al.*, 2016) [14]. Onion is grown in different parts of the country as early *kharif*, *kharif*, late *kharif*, rabi and summer crop depending on the agro-climatic zones. Odisha enjoys three cropping seasons of onion like *kharif*, late *kharif* and rabi. One of the major problems in onion cultivation in the state is improper post-harvest management practices, traditional method of cultivation and unavailability of quality seeds. Quality seed is the basic and critical input for achieving the desired onion production. The availability of quality seed, in time, at affordable price, enables the vegetable farmers to grow the crop during ideal time.

The disease-free healthy seed produces uniform, healthy and vigorous seedling leading to higher yield. The demand for quality onion seed is increasing (Amsalu *et al*., 2014) [1]. However, seed supply is inadequate, its price is increasing every year and onion seed available in the market are poor in quality (Olani and Fikre, 2010) [12].

In onion seed to seed method involves low cost of seed production, early maturity and no need to store bulbs. But it is seen that seed yield is comparatively low and of poor quality if proper infestation measures are not taken.Besides selection of suitable varieties, appropriate time of planting is also one of the important factors, which influences the growth, yield and quality of crop as a climatic factor. Atmospheric temperature, humidity and day length affect the crop as well as seed yield. So, planting at different times is considered to test the suitable dates for quality seed production. As seed to seed method is easy and cost effective, the farmers of west central table land zone of Odisha should be encouraged for onion seed production to meet the seed demand.

Material and Methods

Site description

The field experiment was conducted during the late *kharif* season of 2014-15 and 2015-16 in the experimental plot of All India Network Research Project on Onion & Garlic, College of Horticulture, Odisha University of Agriculture and Technology, Chiplima, Sambalpur, Odisha, India. The experiment consisted of two factors i.e. five planting dates and five onion genotypes under split plot design with three replications.

Treatment and experimental design

The experiment was laid out in split plot design and each treatment replicated three times for planting dates (main plot) and five varieties (sub plot). The soil of experimental field was loamy sand in texture with organic carbon (0.23), pH (5.80), available nitrogen; phosphorous, potassium and sulphur were 230.5 kg ha^{-1}, 21.03 kg ha^{-1}, 114.23 kg ha^{-1} and 9.89 ppm, respectively. Cultural operation for the crop was similar for all the treatments i.e. amount of fertilizers (N: P: K: S) (150:50:50:50 Kg/ha) and other operations as irrigation, weeding and application of plant protection chemicals as and when required. Planting was done in five dates, D_1-10th September, D_2-25th September, D_3-10th October, D_4-25th October and D_5-10th November with five varieties, V_1-Agrifound Dark Red (ADR), V_2-Agrifound Light Red (ALR), V_3-Bhima Shakti, V_4-Bhima Super and V_5-Arka Niketan to find out suitable time of planting for quality seed production and to identify suitable variety for seed production in west central table land zone of Odisha.

Data recorded

Data were recorded on dates of initial bolting, treatment and variety wise to find out days taken from the dates of transplanting to bolting. Total number of seed stalks of 10 randomly selected plants were taken towards maturity of crop and the average of the values were recorded as number of seed stalks per plant. Similarly, length of scape and height of umbel were recorded from ten randomly selected tagged plants by meter scale from the base to the tip during full blooming stage for scape length and umbel length, and average values were expressed in cm. For measuring diameter of scape and umbel middle portion of tagged plants was measured at full bloom stage by digital vernier calliper and expressed in cm. As umbels of selected plants did not mature at a time, they were harvested when about 50% of seeds in an umbel turn black and exposed. In order to prevent shattering of seeds, harvesting was done carefully by holding the umbel in between fingers of left palm and cutting the umbels by right hand. The date of harvesting of umbels were recorded and the days taken for maturity of seeds after bolting were calculated from the date of full bloom of umbels. During entire growth periods of onion plants of both 2014-15 and 2015-16 data on purple blotch infection and per cent thrips infestations were recorded as per the treatment schedules by adopting the standard procedures and subjected to statistical analysis. Correlation analysis was calculated as per Pearson's simple correlation method using the pooled mean of different days of planting using the OPSTAT statistical software, (http://14.139.232.166/opstat/default.asp).

Results and Discussion

Seed yield attributing characters

1. Days taken for bolting after transplanting

As it is evident from Table No. 1 that both dates of planting and variety have significant effect on days taken for bolting after transplanting. The mean data revealed that V_3, recorded maximum days for bolting (88.77) which is 12.69 days more than the average and significantly superior than other varieties. Though the planting dates scored a narrower difference among themselves to come to bolting after planting, there exists a significant difference among themselves. D_5 recorded the lowest number of days (72.37) followed by D_4 (74.23) & both were statistically at par with each other and D_2 recorded maximum days (78.37) for bolting in which both D_1 & D_3 were found at par with D_2.This finding was supported by Morozowska and Holubowicz, 2009 [10].

2. Number of seed stalks per plant

It is observed that number of seed stalks per plant was significantly influenced by dates of planting and varieties. The best seed stalk was produced by V_5 (3.18) and was significantly superior to rest varieties tested. V_5 significantly recorded an increase of 1.10 numbers of spikes over the average.

Results of all the dates of planting were significantly different from each other with respect to number of seed stalks per plant. The mean of both years recorded a significant result with D_2 (3.05) followed by D_1 (2.46), D_4 (1.61) and D_5 (0.82).This results were supported by Sharma and Jarial, 2017 [16].

3. Length of scape

On the perusal of data presented in the Table No. 1, it was observed that variety and dates of plantings had a significant effect on length of scape where V_4 recorded maximum scape length of 61.45 cm and was significantly superior to other varieties.

Regarding the dates of planting D_2 significantly recorded longest scape length 66.11 cm followed by D_1 (60.64 cm) and D_3 (58.53 cm). Finally, shortest scape length was observed in D_5 (33.63 cm). All the treatments are significantly different. This was supported by Mosleh ud-deen, 2008 [11] and Gebeyehu, 2016 [4].

4. Diameter of scape

Scape diameter of onion seed stalks were influenced by varieties and date of planting, recording a significant effect.

Maximum scape diameter of 1.33 cm was observed in V_5 followed by 1.28 cm in V_4, 1.23 cm in V_1, 1.11 cm in V_3 and 1.10 cm in V_2 in which V_5 & V_4; V_4 & V_3; and V_3 & V_2 were at par. Mollah *et al.*, 2015 [9] and Dong *et al.*, 2013 [2] suggested that these results might be due to the genetic characters of variety.

A significant result was also obtained with regards to dates of planting. Maximum scape diameter was recorded in D_2 (1.41 cm) and it was statistically at par with D_3 (1.30 cm), and D_1 (1.27 cm). This was supported by Mosleh ud-deen, 2008 [11] and Gebeyehu, 2016 [4].

5. Diameter of umbel

Umbel diameter was significantly influenced by date of planting as well as varieties. The highest umbel diameter was recorded in V_5 (4.59 cm) followed by V_4 (4.43 cm) and both were statistically at par.

The effect of dates of planting on umbel diameter was also recorded significant results (Gebeyehu, 2016) [4]. Maximum umbel diameter was recorded in D_2 (5. 35 cm) followed by D_1 (4.97 cm), D_3 (4.45 cm), D_4 (3.02 cm) and D_5 (2.29 cm) and all the treatments were significantly different from each other.

6. Height of umbel

Both the varieties and dates of planting had positive and significant effect on the height of umbels in late *kharif* onion seed production. V_4 registered the highest umbel height of 3.54 cm followed by V_5 (3.50 cm), V_1 (3.4 cm), V_2 (2.69 cm) and V_3 (2.53 cm), in which V_4 & V_5 were at par. V_3 recorded the shortest umbel height.

The dates of planting influenced the height of umbel as evidenced from the table. Most significant result was observed in D_2 (4.09 cm) followed by D_1 (3.66 cm), D_3 (3.23 cm), D_4 (2.45 cm) and D_5 (2. 16 cm). The most discouraging result was obtained in D_5 in both the years and mean data analysis report recording shortest umbel height (Gebeyehu, 2016) [4].

7. Incidence of purple blotch

Varieties and dates of planting recorded significant effect on incidence of purple blotch. A significantly maximum and minimum incidence of purple blotch was recorded in V_5 (16.85 %) and V_2 (14.54%) respectively.

Dates of planting also played a significant role in incidence of purple blotch. The pooled data expressed a significant result recording highest incidence in D_2 (19.52) which was at par with D_3 (16.97). Although D_5 (12.31) recorded lowest incidence of purple blotch, it is at par with D_1 (14.93) & D_4 (14.45). This was supported by the findings of Tripathy *et al.*, 2013 [13].

8. Incidence of thrips infestation

Significantly maximum infestation was observed in V_1 recording 13.29% whereas minimum in V_5 (4.21%) followed by V_4 (4.47%), V_2 (4.89%) and V_3 (5.56%). Here, V_5 & V4 and V_4 & V_2 were found to be at par and all the varieties were significantly different from each other with respect to thrips infestation.

Dates of planting also expressed a positive and significant effect on thrips infestation during both the years of study recording maximum mean infestation in D_1 (8.59) followed by D_5 (8.42%), D_2 (6.74%), D_3 (4.97%) & D_4 (3.69%) where D_1 & D_5; D_5 & D_2 and D_3 & D_4 were found to be statistically at par with each other. This was supported by the findings of Tripathy *et al.*, 2013 [13].

9. Days to seed maturity after bolting

Days to seed maturity after bolting is significantly influenced by variety and date of planting. It is evident from Table, No 1 that V_2 took the shortest number of days (33.23) followed by V_1 (37.13), V_3 (43.07), V_4 (45.67) and V_5 recorded the maximum number of days 61.17 for maturity of seeds. All the treatments were significantly different from each other.

As regards the date of planting, all the planting dates were significantly different from each other in days taken for seed maturity after bolting. D_1 recorded maximum number of days (49.37) followed by D_2 (45.90), D_3 (44.00), D_4 (41.80) & D_5 (39.20). Similar, findings have also been reported by Gosai *et al*, 2018 [6].

Total seed yield per ha (kg)

Both the varieties and dates of planting have positive and significant effect on the total seed yield per hectare in late *kharif* onion seed production. V_5 registered highest seed yield of 701.49 kg per hectare and was significantly superior to other varieties. It was followed by V_4 (609.69 kg/ha), V_1 (484.24 kg/ha), V_2 (225.56 kg/ha) and V_3 (105.58 kg/ha).

The dates of planting also influenced the total seed yield per hectare as evidenced from the table. Most significant result was observed in D_2 (809.51kg/ha) followed by D_3 (506.57kg/ha), D_1 (463.86kg/ha), D_4 (247.48kg/ha) and D_5 (99.16kg/ha). The result of present investigation was supported by Kumar *et al.*, 2015 [7] and Gosai *et al.*, 2018 [6].

Table 1: Effect of different planting time and varieties on seed yield attributing characters in onion seed production at west central table land zone of Odisha (pooled)

Parameters	Days taken to bolting after transplanting	Number of seed stalks per plant	Length of scape (cm)	Diameter of scape (cm)	Diameter of umbel (cm)	Height of umbel (cm)	Incidence of purple blotch infestation (%)	Incidence of thrips infestation (%)	Days to seed maturity after bolting	Total seed yield (kg/ha)
D1	77.60	2.46	60.64	1.27	4.97	3.66	14.93	8.59	49.37	147.60
D2	78.37	3.05	66.11	1.41	5.35	4.09	19.52	6.74	45.90	249.43
D3	77.83	2.46	58.53	1.30	4.45	3.23	16.97	4.97	44.00	157.96
D4	74.23	1.61	48.72	1.13	3.02	2.45	14.45	3.69	41.80	78.77
D5	72.37	0.82	33.63	0.93	2.29	2.16	12.31	8.42	39.20	31.84
Se (m)	0.66	0.149	0.681	0.094	0.194	0.173	0.168	0.112	0.563	1.500
CD	1.98	0.446	2.041	0.283	0.581	0.518	0.504	0.336	1.687	4.497
V1	67.57	2.29	51.26	1.23	4.37	3.34	15.06	13.29	37.13	151.80
V2	87.10	1.50	46.95	1.10	3.10	2.69	14.54	4.89	33.23	73.91
V3	88.77	0.94	53.07	1.11	3.49	2.53	15.39	5.56	43.07	37.37
V4	67.93	2.50	61.45	1.28	4.53	3.54	16.34	4.47	45.67	187.82
V5	69.03	3.18	54.90	1.33	4.59	3.50	16.85	4.21	61.17	214.70
Se (m)	0.17	0.036	0.168	0.024	0.047	0.041	0.043	0.031	0.139	0.347
CD	0.50	0.100	0.471	0.068	0.133	0.115	0.121	0.088	0.391	0.977

Correlation analysis

The correlation analysis (Table 2) indicated that the total seed yield (kg/ha) was observed to have statistically significant positive correlation with days taken to bolting after transplanting (0.923), number of seed stalks per plant (0.971), length of scape (cm) (0.935), diameter of scape (cm) (0.963), diameter of umbel (cm) (0.941) and height of umbel (cm) (0.957). Although the seed yield was positively correlated with the days to seed maturity after bolting; but it was statistically non-significant. However, it was negatively correlated (-0.030) with incidence of thrips infestation (%), which showed that higher incidence of thrips, can result in reduction in seed yield.

Table 2: Correlation coefficient matrix among the various parameters

	A	B	C	D	E	F	G	H	I	J
A	1.000									
B	0.980**	1.000								
C	0.973**	0.991**	1.000							
D	0.972**	0.996**	0.990**	1.000						
E	0.979**	0.979**	0.970**	0.958*	1.000					
F	0.942*	0.962**	0.942*	0.935*	0.988**	1.000				
G	0.857NS	0.920*	0.877NS	0.932*	0.840NS	0.851NS	1.000			
H	-0.039NS	-0.087NS	-0.132NS	-0.175NS	0.101NS	0.178NS	-0.241NS	1.000		
I	0.840NS	0.810NS	0.848NS	0.775NS	0.892*	0.862NS	0.522NS	0.260NS	1.000	
J	0.923*	0.971**	0.935*	0.963**	0.941*	0.957*	0.966**	-0.030NS	0.701NS	1.000

A: Days taken to bolting after transplanting; B: Number of seed stalks per plant; C: Length of scape (cm); D: Diameter of scape (cm); E: Diameter of umbel (cm); F: Height of umbel (cm); G: Incidence of Purple blotch infestation (%); H: Incidence of Thrips infestation (%); I: Days to seed maturity after bolting; J: Total seed yield (kg/ha).

** Significant at $P \leq .01\%$, * Significant at $P \leq .05\%$.

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