

## Original Research Article

### Effect of Different Spacing and Varieties on Growth, Quality and Yield in Onion (*Allium cepa* L.)

Comment [U1]: if the name is latin it should be in italics

#### Abstract

The present experiment was conducted at the field of Horticulture Research Farm, BabasahebBhimraoAmbedkar University, Lucknow (Uttar Pradesh) during Rabi season of 2019-2020. The experiment was laid out under factorial randomized block design (FRBCD) and treatments comprised of three varieties i.e. V<sub>1</sub> (Agrifound Light Red), V<sub>2</sub> (NHRDF-Red), V<sub>3</sub> (NHRDF-2) and three planting spacing S<sub>1</sub> (20x7.5cm), S<sub>2</sub> (20x10cm) and S<sub>3</sub> (20x15 cm). The parameters were observed viz. Plant height (cm), Number of leaves /plants, Neck diameter (cm), Bulb diameter (cm), No. of scales, Bulb length (cm). TSS (°Brix), Ascorbic Acid (mg), Total Sugar (%), Reducing sugar (%), Non- reducing sugar (%), Acidity (%) yield per plot (kg) and yield per hectare (q).The results of this study revealed that the combination application of variety (Agrifound Light Red ( V<sub>1</sub>) with spacing 20X 15 cm ( S<sub>3</sub>) was best under Lucknow conditions and lowest values were noted in of variety Agrifound Light Red ( V<sub>1</sub>) with spacing 20X 7.5 cm (S<sub>1</sub>).

Comment [U2]: Not showing the formulation of the problem which became the initial idea of the research

**Keywords:** Acidity, Ascorbic Acid, TSS and Yield

#### 1. Introduction

Onion (*Allium cepa* L., 2n=16) is very common vegetable of Rabi season crop belongs to *alliaceae* family. Onion is also regarded as queen of vegetable (Selvaraj, 1976) This crop is native to Central Asia. Onion is grown throughout the entire world with some major producing countries like China, India, USA, Turkey, Pakistan, Iran, Japan, Spain and Brazil. In the world, India stands first in area (1293 Mha.) and ranks second in production (23610 M tons) after China. India exported fresh onion worth \$328 million and dried onions worth \$112.3 million in Financial year 2020. Export of onion shot up 158% to Bangladesh in the April-July period of 2019-20 (ministry of commerce & industry, Government of India).The crop is very useful for human being because it has several nutritional and medicinal values. The important contents like allicin, allin, and sulphites etc. are present in onion in good amount. Onion has anti-viral, anti-bacterial, anti-allergenic, anti-inflammatory properties and due to the presence of flavonoids it reduces the chance of cancer and diabetes. The antifungal property of onion is due to presence of catechol a phenolic compound. Oil yield methyl and propyl compounds 0.02-0.03g/100g of bulb by steam distillation. Onion is used for treating problems including loss of appetite, upset stomach, and gall bladder disorder, for treating heart and blood vessel problems including chest pain (angina) .It also acts as a very good tonic to a nervous system and purifies blood. The beneficial compound called 'Quercetin' present in onion has shown to be powerful antioxidant. It pungency is due to the presence of Allyl propyl disulphide, (C<sub>6</sub>H<sub>12</sub>O<sub>2</sub>) a volatile oil. The yield of vegetable crops can be increased by choosing a suitable cultivar, judicious use of manures and fertilizers with proper spacing, adequate water supply and cultural practices etc. Therefore, the use of proper geometry to get appropriate plant stand is pre- requisite for higher crop yield per unit area.

Comment [U3]: if the name is latin it should be in italics

Comment [U4]: have not been able to describe the formulation of the problem according to the title. The title emphasizes ideas related to spacing and varieties, but in the introduction it emphasizes function and content

#### 2. Materials and methods

A field experiment was conducted during the rabi season of October to April 2019-20 at Horticulture Research Farm, School of Agricultural Sciences and Technology BabasahebBhimraoAmbedkar University (A Central University), Vidya- Vihar Rae Bareilly Road, Lucknow,. The experimental field was undertaken is geographically, situated at an elevation of 111 meter above mean sea level in the sub- tropical climate of central Uttar Pradesh at 26°56 North Latitude 80°52 east longitude. According to agro-climatic conditions of Uttar Pradesh state, Lucknow falls under central plains region and receives on an average 1000 mm of Rainfall; the climate ranges from 22°C to 45°C in summer, minimum temperature ranging from 3.5 -15°C in winter and relative humidity ranging from 60-80% in different season of the year. The soil of field was texturally classified as sandy clay loam and slightly alkaline in reaction. pH is ranging from about 7.5 to 8.5. The treatments comprised of three varieties i.e. Agrifound Light Red, NHRDF-Red, NHRDF-2 and three planting spacing (20×7.5cm, 20×10cm and 20×15 cm) thus forming nine treatments combinations were laid out in a factorial randomized block design of practices. Observations to be recorded growth characters viz. Plant height (cm), Number of leaves /plants, Neck thickness (cm) ; bulb characters viz. Bulb diameter (cm), No. of scales, Bulb length (cm); quality characters viz. TSS (°Brix), Ascorbic Acid (mg); Total Sugar (%), Reducing sugar(%), non- reducing sugar(%) and Acidity(%) and yield parameters viz. yield per plot ( kg / ha) and yield per hectare ( q/ha). Statistical analysis of data was obtained in different set of experiments was calculated following the standard procedure as stated by Panse and Sukhatme.

**Comment [U5]:** what is the basis for selecting spacing?

### 3. Results and Discussion

#### 3.1 Growth characters

##### Plant height

The plant height was recorded at 30, 60, 90 DAT and at harvest stage. The data showed that there was significant difference among varieties and spacing on plant height. The Data presented in table 1, clearly indicate that at 30DAT, Variety V<sub>3</sub> (NHRDF-2) had highest plant height (16.90cm) followed by variety V<sub>2</sub> (NHRDF-Red) = 16.48cm, at 60 DAT variety V<sub>2</sub> (NHRDF-Red) had maximum plant height (43.69cm) followed by V<sub>3</sub> (NHRDF-2) =40.87 cm, 90 DAT Variety V<sub>3</sub> (NHRDF-2) had maximum plant height ( 65.33 cm) followed by V<sub>2</sub> (NHRDF- Red) = 63.29 cm and at harvest stage variety V<sub>3</sub> (NHRDF-2) produce maximum height (65.33cm) followed by variety V<sub>1</sub>(Agrifound Light Red ) = 64.77cm . In case of spacing, there were also significant variations in observations. At all stages (30, 60, 90 DAT and harvesting ) maximum plant height was recorded with the spacing of S<sub>3</sub> (20X 15cm), 17.65, 45.34, 65.68 and 67.15 cm followed by S<sub>2</sub> (20X10cm); 16.58, 39.70, 61.85 and 63.64cm respectively. The combined effect of varieties and plant spacing also revealed that there was significant variation on plant height at all stages of plants growth. Among the interactions, at the all stages (30, 60, 90 and at harvesting ), the maximum plant height was recorded under V<sub>1</sub>S<sub>3</sub>; 18.95, 48.55, 68.02, 69.53 cm followed by V<sub>3</sub>S<sub>2</sub>. Similar result was reported by Jilani *et al.* (2010).

**Comment [U6]:** in discussing, don't just describe the data, moreover it has been presented in tables. Must be able to provide an analysis of the data obtained. The discussion must also be compared with the characteristics of the varieties used, because each variety has its own characteristics

##### Number of leaves

The number of leaves/plant were counted at 30, 60, 90 and harvest stage. The data was recorded is presented in the table 1 indicate that there was significant change in varieties and spacing on number of leaves / plant at all the stages of growth. The data revealed that at 30 DAT highest number of leaves /plant (3.49) were recorded in V<sub>3</sub> (NHRDF- 2) followed by variety V<sub>1</sub>Agrifound Light Red (3.42), at 60 DAT maximum number of leaves / plant (4.37) were in variety V<sub>3</sub> NHRDF-2 followed by V<sub>1</sub>. Agrifound Light Red (4.34) and 90 DAT maximum number of leaves were in variety NHRDF-2 (6.38) followed by V<sub>1</sub>Agrifound Light Red (6.18)and at harvest V<sub>1</sub> (Agrifound Light Red) produce maximum number of leaves / plant (10.37) followed by variety V<sub>3</sub> NHRDF-2 (10.18). In case of spacing, It was recorded that the plant

spacing  $S_1$  (20×15cm) produce the maximum number of leaves/plant (3.48) followed by (3.44) at 30 DAT, the plant spacing  $S_3$  (20×15cm) produce the maximum number of leaves /plant (4.36) followed by  $S_1$  (20×7.5cm) (4.35) at 60 DAT, the plant spacing  $S_3$  (20×15) produce maximum 6.50 leaves per plant followed by  $S_2$  (20×10)= 6.04 at 90 DAT and the spacing  $S_3$  (20×15 cm) produce maximum number of leaves/plant (11.13) followed by  $S_2$  (20×15cm) =9.88 at harvest. The combination effect of the variety and plant spacing was also found significant effect on number of leaves /plant at all stages of plant growth. Among interactions, the maximum number of leaves/plant (3.64, 4.54, 6.54 and 9.54) were recorded in  $V_1S_3$  followed by  $V_2S_1$  (3.55, 4.45, 6.45 and 9.45) at all stages respectively. These findings were closely related with the result of Devi *et al.* (2008).

### Neck thickness

The data regarding to neck thickness (cm) was recorded at 30, 60, 90 DAT and at harvest. The data presented in Table 1 shows significant variation of varieties and spacing on neck thickness. Data shows that highest neck thickness (0.427, 0.713, 1.996 and 2.121 cm) as reported in variety Agrifound Light red followed by variety NHRDF-2 (0.334, 0.567, 1.883 and 2.114cm ) respectively.

It was noticed that plant spacing was also significantly affected by Varieties. Plant spacing  $S_2$  (20×10cm) showed maximum neck thickness (0.388cm) followed by  $S_3$  (20×15cm) = 0.352 cm at 30DAT, spacing  $S_1$  (20×15 cm) produce maximum neck thickness (0.633cm) followed by  $S_2$  (20×10cm) = 0.578cm at 60 DAT, maximum neck diameter was recorded in  $S_3$  (20×15) = 1.98 followed by  $S_1$  (20 X 7.5)=1.91 at 90 DAT and plant spacing  $S_3$  (20×15cm) recorded maximum neck thickness (2.141cm) followed by  $S_2$  (20×10 cm)= 2.107cm at harvest. The combined effect of variety and plant spacing also showed that there was significant change on neck thickness at all stages of plants growth. Among the interactions, the maximum neck thickness was observed in  $V_1S_2$  (0.513cm) followed by the  $V_1S_3$  (0.420cm) at 30 DAT, maximum thickness ( 0.853, 2.043, 2.157cm) at 60, 90 DAT and harvest was noted in  $V_1S_3$  followed by  $V_1S_1$  ( 0.673, 1.990 and 2.107cm). The findings are closely related with Kumar *et al.* (2021).

**Comment [U7]:** in discussing, why not provide an analysis of the side of irradiation and competition in getting nutrition?

**Comment [U8]:** where is the result of the analysis?

**Comment [U9]:** which part and how is it related?

## 3.2 Bulb characters

### Bulb Diameter

The data regarding to Bulb diameter of onion is presented in Table1. After perusal of the data, it is clear that maximum bulb diameter (6.86cm) was noted in Variety  $V_2$ = NHRDF- Red followed by  $V_3$  =NHRDF-2 (6.86 cm) and minimum in  $V_1$ = Agrifound Light Red (5.69cm) respectively. The effect of the plant spacing on bulb diameter (cm) was also found significant and maximum diameter was recorded in  $S_2$  20×10cm =7.14cm followed by  $S_1$  (20×10cm) = 6.20cm and minimum diameter was found in  $S_3$ (20×15cm) = 6.18cm. The combined effect of varieties and spacing on bulb diameter (cm) was also found significant and maximum diameter was found in  $V_1S_3$  = 7.45 cm followed by  $V_2 S_1$  7.45 cm),  $V_1S_2$  (6.57 cm),  $V_2S_2$  (5.69cm) and minimum diameter was found in  $V_1S_1$  (4.80cm). Similar findings were also noticed by Khan *et al.* (2003); and Jilani *et al.* (2010).

### Bulb length

The data regarding to bulb length of onion has is showed in Table 1. After perusal of the data, it is clear from the table that highest bulb length was noted in variety  $V_2$  NHRDF-Red = (5.29 cm) followed by  $V_3$ : NHRDF-2, = 5.10cm while lowest bulb length (cm) was found in variety  $V_1$  (Agrifound Light Red) = 4.86cm. The effect of the plant spacing on bulb length was also found significant and maximum bulb length was found at  $S_2$  (20x10cm) = (5.72cm) and it was found minimum in  $S_1$  (20x7.5cm) = 4.69. The combined effect of plant varieties and spacing on bulb length (cm) was also found significant and maximum length was found in  $V_2S_2$  (6.53cm) and minimum length was found in  $V_1S_1$  as (4.42cm). This result corroborated the finding of Jilani *et al.* (2010).

#### **Number of Scales**

The data regarding to number of scales of bulb is presented in table 1. It is evident from the data that highest number of scales (11.67) was noted in variety  $V_3$  (NHRDF- 2), while lowest number of scales (10.11) reported in variety  $V_2$  (NHRDF-Red). The effect of the plant spacing on number of scales was also found significant and maximum scales were found at  $S_3$  (20x15cm) =11.89 and lowest number of leaves was found in  $S_2$  (20x10cm) = 10.22. The combined effect of plant varieties and spacing on number of scales was also found to be significant and maximum scales were found in  $V_1S_3$  (12.33) and minimum number leaves was found in  $V_1S_2$  (9.00). These results are close conformity with earlier reports of Jilani *et al.* (2010).

#### **3.3 Quality Parameters**

##### **TSS**

An inquisition of data in table 2 clearly indicate that among the varieties maximum TSS (11.71° brix) was recorded in variety  $V_1$  (Agrofound Light Red) followed by  $V_3$  ( NHRDF-2= 1.18° brix. and the minimum TSS (10.80° brix) was noted of variety  $V_2$  (NHRDF-Red).The maximum TSS content (11.45° brix) was noted as plant spacing  $S_2$  (20x10cm) while the minimum TSS content (10.89° brix) observed under plant spacing  $S_1$  (20x7.5cm). The combined effect of varieties and plant spacing showed significant influence on TSS content in different onion varieties spacing. Among the treatments ( $V_1S_3$ ) recorded highest TSS (12.80° brix) and minimum was noted in  $V_2S_1$  (10.08° brix).

##### **Ascorbic Acid**

The findings of the ascorbic acid of present experiment is showed in table 2 which showed significant variation in variety and plant spacing on ascorbic acid content. It is clear from the data that variety  $V_3$  (NHRDF-2) contain highest ascorbic acid content (0.74mg /100g) followed by  $V_2$  (0.70mg/100g) and the lowest ascorbic acid content was noted in  $V_1$  (0.69mg/100g). Among the plant spacing maximum ascorbic acid was determine with  $S_2$  (20X10) = 0.76mg/100g followed by  $S_3$  (20x15cm) = 0.74mg/100g whereas minimum ascorbic acid content as (0.64mg/100g) was noted under plant spacing  $S_1$  (0.63 mg/100 g). The combined effect of variety and plant spacing also revealed statistically significant influence on ascorbic acid content. Among the combination  $V_1S_3$  recorded highest (0.84mg/100g) ascorbic acid and minimum was noted in  $V_1S_1$  (0.42mg/100g).

##### **Reducing Sugar**

The data regarding to reducing sugar presented in the Table 2. and showed significant effect of variety and plant spacing was found on reducing sugar content in bulb. Highest reducing sugar content (7.56%) was found in  $V_2$  followed by  $V_1$  (6.67%) while The lowest reducing sugar content (6.61%) was noted in  $V_3$ . Among the plant spacing maximum reducing sugar (7.26%) was recorded with  $S_2$ (20x10cm) followed by  $S_3$  (20x15cm,7.25%) whereas The minimum reducing sugar content (5.50%) was noted under plant spacing  $S_1$ (20x7.5cm). The combined effect of the variety and plant spacing revealed statistically significant influence on reducing sugar content. Among the treatment  $V_1S_3$  recorded highest reducing sugar (8.25%) and minimum (5.50%) was noted in  $V_1S_1$ .

## Non -Reducing Sugar

Significant differences were observed among different treatments for non - reducing sugar as presented table 2. It is clear from data that variety  $V_1$  had highest non-reducing sugar content (8.79%) followed by  $V_3$  (8.78%) while the lowest non- reducing sugar content (8.36%) was noted in  $V_2$ . Among the plant spacing maximum non-reducing sugar (9.31%) was determine with  $S_3$  (20x15cm) followed by  $S_1$  (20x7.5cm) = 8.41% whereas the minimum non-reducing sugar content as 8.30% was noted under plant spacing  $S_1$  (20x7.5cm). The combined effect of the variety and plant spacing revealed statistically significant influence on non-reducing sugar content. Among the treatment  $V_1S_3$  recorded highest (9.76%) non reducing sugar and minimum was noted in  $V_2S_1$  = 7.76%.

## Total Sugar

The data showed significant variation of variety and plant spacing on total sugar content in bulb as presented in Table 2. It is evident from the data that variety  $V_2$  contain highest total sugar contents (17.05%) followed by  $V_3$  (NHRDF-2; 16.54%). The lowest total sugar content was noted in  $V_1$  (Agrifound Light Red; 16.13%). Among the plant spacing, maximum total sugars (16.87%) was determined with  $S_2$  (20x10 cm) followed by  $S_3$  (20x15 cm; 16.59%). The minimum total sugar content (16.27%) was noted under plant spacing  $S_1$ (20x7.5cm). The different between  $S_2$  and  $S_3$  are found significant. The combined effect of variety and plant spacing revealed statistically influence on total sugar content. Among the treatment  $V_1S_3$  recorded highest total sugar (18.19%) and minimum (14.69%) was noted in  $V_1S_1$ .

## Acidity

As the data revealed from the table 2 It is clear that variety  $V_1$  had highest acidity content (0.039%) followed by  $V_3$  (0.037%) while the lowest acidity content (0.035%) was found in by  $V_2$ . Among the plant spacing maximum acidity (0.41%) was determined with  $S_2$  (20x10cm) followed by  $S_3$  (20x15cm)= 0.040% while minimum acidity content (0.31%) was noted under the plant spacing  $S_1$ (20x7.5cm). The combined effect of variety and plant spacing revealed statistically significant influence on acidity content. Among the combination  $V_1S_3$  recorded highest acidity (0.047%) and lowest was noted in  $V_1S_1$  (0.030%).

## 4. Yield Parameters.

### Yield per Plot

The data recorded on yield per plot is given in table 2. it is clear from the table that highest yield (4.102 kg) was recorded in variety  $V_1$  (Agrifound Light Red), while lowest yield (3.25kg) in variety  $V_2$ (NHRDF-Red).The effect of plant spacing on yield per plot was found significant and h highest yield (3.72kg) was found at  $S_1$  (20x7.5cm) whereas lowest yield (3.35 kg) was found in  $S_3$  (20x15cm). The combined effect of plant varieties and spacing on yield per plot (kg) was also found significant and maximum yield (4.49kg) was found at  $V_1S_3$  and minimum yield (2.69kg) obtained in  $V_3S_3$ .

### Yield per Hectare

A glance of data in table 2 showed significantly variation by different treatments in yield per hectare. It is clear from the table that highest yield (331.28q/ha) was obtained in variety  $V_1$ (Agrifound Light Red) while lowest (262.15q) was found in variety  $V_2$  (NHRDF-Red). The effect of plant spacing on yield per hectare was also found significant and maximum yield (301.42q) was found at  $S_1$  (20x7.5cm) and lowest yield (274.68q) was observed in  $S_3$  (20x15 cm. )The combined effect of the varieties and spacing on yield per hectare was also found significant and highest yield (365.85q) was found at  $V_1S_3$  while lowest yield (218.83q) has been found in  $V_3S$

**Table 1. Treatment wise variation in plant height, leaf and bulb numbers**

UNDER PEER REVIEW

Treatment	Plant Height				Number of Leaves (cm)				Neck thickness (cm)			Bulb diameter (cm)	Number of scales	Bulb height (cm)
	30 DAT	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90DAT	At harvest		

Comment [U10]: check how to present the table

Effect of Varieties

Agrifound Light Red (V <sub>1</sub> )	16.06	39.84	62.96	64.7	3.42	4.34	6.18	10.37	0.427	0.713	1.996	2.121	5.69	10.66	4.86
NHRDF-Red (V <sub>2</sub> )	16.48	43.69	63.29	62.63	3.39	4.27	5.95	10.12	0.327	0.506	1.839	2.058	6.97	10.1	5.29
NHRDF-2 (V <sub>3</sub> )	16.91	40.87	65.33	65.33	3.49	4.37	6.38	10.18	0.334	0.567	1.883	2.114	6.86	11.67	5.10
SEm(±)	0.19	0.33	0.16	0.16	0.021	0.02	0.02	0.02	0.01	0.03	0.02	0.03	0.31	0.23	0.27
CD(P=0.05)	0.57	1.02	0.48	0.48	0.06	0.07	0.07	0.07	0.03	0.09	0.09	0.10	0.99	0.69	0.83

Effect of Spacing

20x7.5 (S <sub>1</sub> )	15.21	39.35	60.37	61.95	3.48	4.26	5.97	9.66	0.348	0.673		2.046	6.20	10.33	4.69
20x10 (S <sub>2</sub> )	16.58	39.70	61.85	63.64	3.38	4.27	6.04	9.88	0.388	0.578	1.817	2.107	7.14	10.22	5.72
20x15 (S <sub>3</sub> )	17.65	45.34	65.68	67.15	3.44	4.35	6.50	11.13	0.352	0.633	1.989	2.141	6.18	11.89	4.84
SEm(±)	0.19	0.33	0.35	0.16	0.02	0.02	0.02	0.02	0.012	0.032	0.025	0.036	0.312	0.23	0.27
CD(5%)	0.56	1.02	0.10	0.48	0.06	0.07	0.07	0.07	0.038	0.097	0.077	0.106	0.993	0.69	0.83

Effect of interaction

V <sub>1</sub> S <sub>1</sub>	14.29	35.64	58.36	59.83	3.33	4.23	6.23	9.22	0.347	0.673		2.107	4.80	10.67	4.42
V <sub>1</sub> S <sub>2</sub>	14.95	35.32	62.49	64.97	3.34	4.24	6.24	9.24	0.513	0.613	1.953	2.080	6.57	62.24	4.83
V <sub>1</sub> S <sub>3</sub>	18.95	48.55	68.02	69.53	3.64	4.00	6.54	9.54	0.420	0.853	2.043	2.157	7.45	65.67	5.81
V <sub>2</sub> S <sub>1</sub>	14.70	42.36	64.45	60.47	3.55	4.45	6.45	9.45	0.330	0.470	1.713	1.920	7.08	58.31	4.61
V <sub>2</sub> S <sub>2</sub>	16.46	43.00	62.51	61.78	3.29	4.19	6.19	9.20	0.317	0.503	1.853	2.110	5.69	59.89	6.53
V <sub>2</sub> S <sub>3</sub>	18.28	45.69	63.29	65.62	3.29	4.19	6.19	9.19	0.330	0.543	1.950	2.143	6.38	58.03	4.74
V <sub>3</sub> S <sub>1</sub>	16.64	40.04	58.30	66.29	3.50	4.34	6.40	9.40	0.367	0.580	2.033	2.110	6.71	64.26	5.03
V <sub>3</sub> S <sub>2</sub>	18.34	40.78	60.56	64.15	3.48	4.38	6.38	9.38	0.333	0.617	1.643	2.130	7.39	59.17	5.32
V <sub>3</sub> S <sub>3</sub>	15.73	41.77	65.73	65.55	3.51	4.34	6.34	9.34	0.303	0.503	1.973	2.123	6.48	61.87	4.47
SEm(±)	0.33	0.58	0.61	0.28	0.037	0.42	0.42	0.43	0.022	0.055	0.044	0.063	0.54	1.10	0.47
CD(5%)	0.99	1.77	1.85	0.84	0.01	1.56	0.12	0.13	0.064	0.162	0.134	0.185	1.59	3.34	1.4

Treatment	TSS (Brix)	Ascorbic Acid (mg)	Total Sugar (%)	Reducing Sugar (%)	Non Reducing Sugar (%)	Acidity (%)	Yield per plot (kg)	Yield per hectare (q)
<b>Effect of Varieties</b>								
Agrifound Light Red (V <sub>1</sub> )	11.17	0.69	16.13	6.71	8.79	0.039	4.10	331.41
NHRDF-Red (V <sub>2</sub> )	10.80	0.71	17.05	7.59	8.51	0.037	3.25	262.16
NHRDF -2 (V <sub>3</sub> )	11.17	0.74	16.54	6.59	8.78	0.037	3.46	281.48
SEm±	0.05	0.02	0.07	0.06	0.04	0.003	0.12	9.62
CD(P=0.05)	0.15	0.06	0.21	0.02	0.14	0.009	0.36	29.10
<b>Effect of Spacing</b>								
20x7.5 (S <sub>1</sub> )	10.89	0.63	16.27	6.38	8.42	0.031	3.72	301.41
20x10 (S <sub>2</sub> )	11.45	0.76	16.87	7.26	8.36	0.041	3.75	298.83
20x15 (S <sub>3</sub> )	11.33	0.74	16.59	7.25	9.31	0.040	3.35	274.69
SEm(±)	0.05	0.02	0.07	0.06	0.04	0.003	0.12	9.62
CD(P=0.05)	0.15	0.06	0.21	0.20	0.13	0.009	0.36	29.10
<b>Interaction effect</b>								
V <sub>1</sub> S <sub>1</sub>	10.29	0.42	14.69	5.50	8.29	0.030	4.12	343.87
V <sub>1</sub> S <sub>2</sub>	12.04	0.80	15.52	6.27	8.32	0.040	3.70	284.13
V <sub>1</sub> S <sub>3</sub>	12.80	0.84	18.19	8.38	9.76	0.047	4.49	365.85
V <sub>2</sub> S <sub>1</sub>	10.08	0.68	17.97	7.24	7.77	0.030	3.12	239.71
V <sub>2</sub> S <sub>2</sub>	11.23	0.73	17.08	8.32	8.63	0.040	3.78	307.39
V <sub>2</sub> S <sub>3</sub>	11.10	0.70	16.11	7.19	9.13	0.040	2.86	239.37
V <sub>3</sub> S <sub>1</sub>	12.32	0.80	16.17	6.40	9.19	0.033	3.94	320.66
V <sub>3</sub> S <sub>2</sub>	11.1	0.73	18.01	7.19	8.13	0.043	3.75	304.95
V <sub>3</sub> S <sub>3</sub>	10.11	0.68	15.46	6.17	9.02	0.033	2.69	218.83

<b>SEm(±)</b>	0.08	0.03	0.12	0.11	0.07	0.005	0.20	16.67
<b>CD (5 %)</b>	0.26	0.11	0.37	0.35	0.23	0.014	0.62	50.40

Table 2. Treatment wise variation in total sugar, acidity and yield per plant

Comment [U11]: check how to present the table

UNDER PEER REVIEW

## Conclusion

From the above results, it can be concluded that variety Agrifound Light Red with spacing 20X 15 producing significantly highest growth , yield and quality bulb compared to other varieties and spacing. The values of growth, yield and quality characters were found to be decreased with the decreasing of plant spacing and finally the minimum values of these parameters were recorded in the closest spacing 20X 7.5cm. The plant grown under wider spacing received more nutrient light and moisture compared to the closer spacing which is the probably reason of better performance and yield of individual onion in wider spacing.

## References

- Bhagchandani PM, Netrapal, Singh N, Choudhary B.** White onion for dehydration. *Indian Horticulture*. 1980; 24:2.
- Bijaya Devi AK, Lavid AN, Singh G, Prasad A.**Effect of spacing and bulb size on growth and bulb yield of onion. *BhartiyaKrishiAnusandhanPatrika*. (2008); 23(1):40-44.
- Das, RC, Behara SN , Sahoo AC** Spacing and nitrogen fertilization on the growth and yield of onion (*Allium cepa* L.) var. Red globe. *Indian J. Agric. Res.* (1972) ; 69 6 (1):45-50
- J McCreary, DJ.** The effect of plant density on shape, size, uniformity, soluble solid content and yield of onion suitable for pickling. *J. Hort.Sci.* (1985) 60(1): 83-87.
- Jilani MS, Ahmed P, Waseem K, Kiran M.** Effect of plant spacing on growth and yield of two varieties of onion (*Allium cepa* L.) under the agro climatic conditions of D.I Khan. (2010). *Pak. J. Sci.*, 62:1.
- Khan MA, Hasan MK , Miah MAJ , Alam MM, Masum ASMH .** Effect of plant spacing on the growth and yield of different varieties of onion. *Pakistan Journal of Biological Sciences* (2003). 6(18): 1582-1585.
- Kumar D, Singh, PV , Kumar A.** Effect of different level of spacing on growth and yield of onion (*Allium cepa* L.). *Agricultural Science Digest*. 2001; 21(2): 139-140.
- Kumar P, Lata R, Maurya SK and Singh V.** Effect of levels of spacing and varieties on growth of onion ( *Allium cepa* L.). *International Journal of current microbiology and applied science*. 2021; 10(3) 1420- 1426.
- Kumar H, Singh JV, Kumar A, Singh M.** Studies on the effect of spacing on growth and yield of onion (*Allium cepa*L.). Cv. Patna Red. *Indian J Agric. Res* (1998).; 32:134-138.
- Panse VG, Sukhatme PV).** Statistical Methods for Agriculture Workers. Publication and information division. ICAR, New Delhi (1989).

**Selvaraj S.** Onion: Queen of the kitchen. *Kisan World*, (1976) 3 (12): 32-34

**Singh, SR and BP Sachan.** Evaluation of different bulb size , spacing and varieties for higher seed yield and yield attributing trails on onion (*Allium cepa* L.). *Crops Res. Hisar*(1999).. 17 (3):351-355.

**Singh, S, Rathore, SVS.** Effect of bulb spacing on seed production of onion (*Allium cepa* L.). *Punjab Hort.*, (1977). 17: 75-77.

**Comment [U12]:** the references used are very old, preferably using the last 5-10 years

UNDER PEER REVIEW