

Original Research Article

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## Onion Cultivation under Low Cost Low Plastic Tunnels for Restricting Over Winter in Eastern Himalayan Region

Moirangthem Sanju Singh<sup>1\*</sup>, Deepak Jhajharia<sup>1</sup>, Khwairakpam Lily Devi<sup>1</sup>,  
Sapam Rajesh Kumar<sup>2</sup>, Ayam Pushparani Devi<sup>3</sup> and R. Abdul Fiyaz<sup>4</sup>

<sup>1</sup>College of Agricultural Engineering and Post Harvest Technology, CAU,  
Ranipool, Gangtok, Sikkim, 737135 India

<sup>2</sup>College of Horticulture, Bermiok, Gangtok, Sikkim, India

<sup>3</sup>Krishi Vigyan Kendra, Sipahijala, Agartala, Tripura, 799102 India

<sup>4</sup>ICAR-Indian Institute of Rice Research, Rajendranagar, Hyderabad - 500 030, India

\*Corresponding author

### ABSTRACT

The present investigation was undertaken to grow vegetable crops during extreme winter condition in north Sikkim condition where snowfall is the biggest problem in vegetable production. Very little research scientific cultivation of vegetable has been conducted in the past and until now scientific production of vegetable is not available. By keeping the above point, an experiment was conducted during 2017-18 and 2018-19 to study the effect of onion cultivation under plastic low cost low tunnels for restricting over winter in eastern Himalayan region at farm of College of Agricultural Engineering and Post-Harvest Technology, Ranipool, Sikkim. The experiment was laid in factorial randomized block design with 10 treatments in three replications. The treatments comprised the three different height of low tunnel i.e., 70 cm (H<sub>1</sub>); 85 cm (H<sub>2</sub>) & 100 cm (H<sub>3</sub>), Four varieties of onion i.e F1 hybrid “Rani” -V<sub>1</sub>, , Nasik red - V<sub>2</sub>, “Minar” -V<sub>3</sub>, Leader -V<sub>4</sub> and control (open) condition V<sub>1</sub>, V<sub>2</sub>, V<sub>3</sub>, V<sub>4</sub>. The results revealed that the growth parameter and yield attributing characters were significantly influenced by different low cost low tunnel height and onion varieties. It was seen that interaction of 100 cm low tunnel height and the variety “Nasik red” produced comparable height, number of leaves, survival percentage, bulbing percentage and bulb diameter. In case of Days to harvest, minimum was recorded in 100 cm tunnel height and the variety “minar”. Among all the treatment, 100 cm tunnel height with an onion variety “Nasik Red” showed better performance for all the parameter studied and can be considered basis for studying the effect of other agronomic practices.

#### Keywords

Tunnel Height,  
Onion varieties,  
Microclimate,  
Overwinter

#### Article Info

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### Introduction

The present investigation was undertaken to grow vegetable crops during extreme winter condition in north Sikkim condition where

snowfall is the biggest problem in vegetable production. India is the second largest onion growing country in the world. Typically, onions are a spring-planted crop, sown for harvest in late summer and kept through as

much of the winter as possible. Typically, onions are a spring-planted crop, sown for harvest in late summer and kept through as much of the winter as possible. But even with good, cool, dry storage conditions, winter onions eventually turn dark in the center and send out long, green shoots, and there's a long wait before the next year's harvest. The best way to bridge the onion gap is to plant them now for overwintering by using low cost plastic low tunnel. Low tunnels are miniature structures producing green-house like effect in which plastic sheets are used for roof covering of the tunnel with shaped construction having low height, which is built with steel bars. These tunnels facilitate the entrapment of carbon dioxide, thereby enhancing the photosynthetic activity of the plants and hence the yield. These structures also protect the plants from the high winds, rain, frost and snow. Besides being inexpensive, they are easy to construct and dismantle. Low tunnels are being used for producing high quality, high valued nurseries and crops such as tomatoes, cucumber, radish, beans and capsicum (Lodhi *et al*, 2015). Similarly, Monteiro *et al.*, 2002 also reported that the production obtained under protected condition was higher and of better quality. Saini and Singh, 2006 was reported that there was no significant effect on the yield of chili under low tunnel polyhouse due to variation in perforations on polythene cover. Similar finding was also reported by Arin and Ankara, 2001 to determine the effects of low tunnel, mulching and pruning on yield and earliness of tomato in unheated glass house and showed that there was an increase of 643.42% in height (relative to height at the planting time) of the plants grown under low tunnel than those grown without tunnel (602.87%). The idea of using low tunnels was particularly appealing because in late winter and early spring it is a difficult time to find local food in the Eastern Himalayan region. Keeping in view, this experiment was

undertaken to study the effect of Onion cultivation under low cost low plastic tunnels for restricting over winter in eastern Himalayan region.

## **Materials and Methods**

An experiment was conducted for two consecutive years during October to June, 2017 and 2018 at All India Coordinated Research Project on Plasticulture Engineering and Technologies (AICRP-PET) experimental field of College of Agricultural Engineering and Post-Harvest Technology (CAEPHT), Central Agricultural University (CAU), Ranipool, Sikkim, India to study the Onion cultivation under low cost low plastic tunnels for restricting over winter in eastern Himalayan region on growth, yield and survival percentage of onion under low cost low plastic tunnel in Sikkim condition. The experiment comprised of 10 treatments [viz.T1: 75cm Tunnel height, T2: 90cm Tunnel height, T3: 100cm Tunnel height, T4: onion variety F1 hybrid "Rani", T5: onion variety "Nasik red", T6: onion variety "Minar", T7: onion variety "F1 hybrid "Rani" (control), T8: "Nasik red" (control), T9: "Minar" (control) and T10: "Leader" (control) with three replications following Factorial Randomized Block Design (FRBD).

The site is located in East Sikkim District, Sikkim, India, at 27°17.454' to 27°17.508' N latitude and 88°35.595' to 88°35.635' E. The mean maximum and a minimum temperature range from 26 to 36°C and 9.4 to 25.4°C respectively, with humidity ranging from 60 to 97% and 24 to 82%, respectively. The soil has a textural composition of sand, silt, and clay as 62%, 23%, and 15% respectively. The available moisture content of the soil (AWC) is 15% by weight. The soils of Sikkim are generally acidic, pH ranging from 4.3 to 6.4 with mean value of 5.37. The soil texture is silty to clay loam with depth varying from a

few inches to several feet. Organic matter content is high with a mean value of 2.74%. The microclimate data during the period of experimentation are presented in Fig. 1.

Onions seeds were obtained from reliable seed distributor from Siliguri, West Bengal. In the nursery bed, seedling was raised under the plastic and 40-45 days old seedling were selected and transplanted in individual plots of 15 cm raised beds having a dimension of 1 m width and 3 m long bed with a spacing of 10 x 30 cm. The beds were covered with three different low tunnels height, consisting of metal conduit hoops that were placed 1 m apart. The tunnels were then covered with 6 mil GH plastic on November 17. The tunnels were left undisturbed until the bulb developmental stage. After three months of transplanting, the plastic covers of low tunnels were removed for initiation of bulb formation in onion. Digital thermometer was placed at the individual treatment to record the microclimate parameters for three months from the date of transplanting. After three months of transplanting, the plastic covers of low tunnels were removed for initiation of bulb formation in onion.

Statistical analysis was performed with SAS version 9.2 (SAS, 2010, SAS Institute Inc., Cary, NC, USA). SAS's PROC GLM procedure was used to conduct Analysis of Variance (ANOVA) to know the individual effects of tunnel height and onion varieties and also interaction on growth characteristics, survival percentage and yield component of onion varieties. Furthermore, multiple means comparison was completed for significant ( $P < 0.05$ ) comparing the least square means of the corresponding treatment combinations.

## **Results and Discussion**

As per the result shown in table 1, the two factors significantly affected the response

measurements either individually (main effects) or jointly (interaction effects). Tunnel height affected days to harvest, fresh weight, yield per hectare, survival percentage, bulbing percentage and bulb diameter; onion varieties affected to plant height, number of leaves, days to harvest, fresh weight, yield per hectare, survival percentage, bulbing percentage and bulb diameter; the interaction affect plant height, days to harvest, yield per hectare, survival percentage, bulbing percentage and bulb diameter.

### **Effect of growth attributing characteristics, yield attributing character and survival percentage**

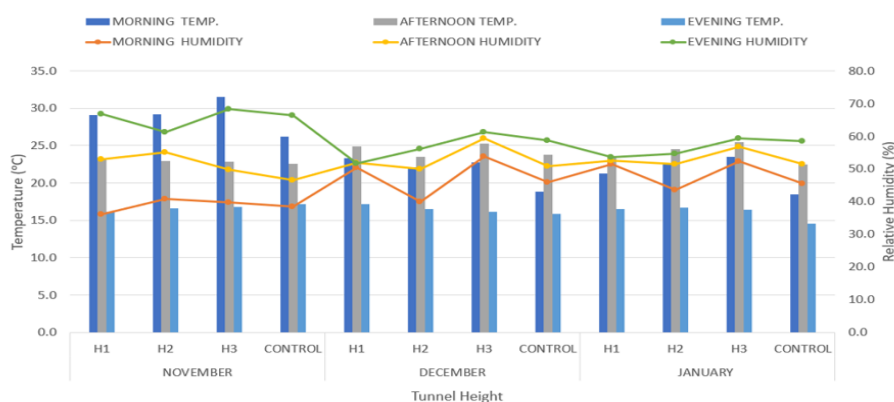
Critical observation of plant height revealed significantly different result in respect to microclimate changes in different low tunnel heights and varieties. It was seen that the variety 'Nasik Red' (37.85 cm) produced the highest plant height which was at par with F1 hybrid Rani (37.40). However, there was no significant difference for plant height among the tunnel heights (table 1). Higher air temperature was observed in this experiment inside the low cost low plastic tunnel relative to control as open condition which encouraged vegetative growth and development at the beginning initial stage of the crop (Fig 1, table1). Result also shows that there was a significant difference for number of leaves on onion varieties. However, number of leaves was not affected by tunnel heights. The maximum number of leaves (5.17) was recorded in the variety "Nasik red" which was at par with 'leader' (4.92) and the minimum (2.75) was recorded in the variety "F1 hybrid Rani" (Table 1).

Minimum days to harvest (105.41) were recorded in 100 cm low tunnel height which was significantly higher as compared to lower tunnel height. Minimum days to harvest were significantly showing differences to varieties.

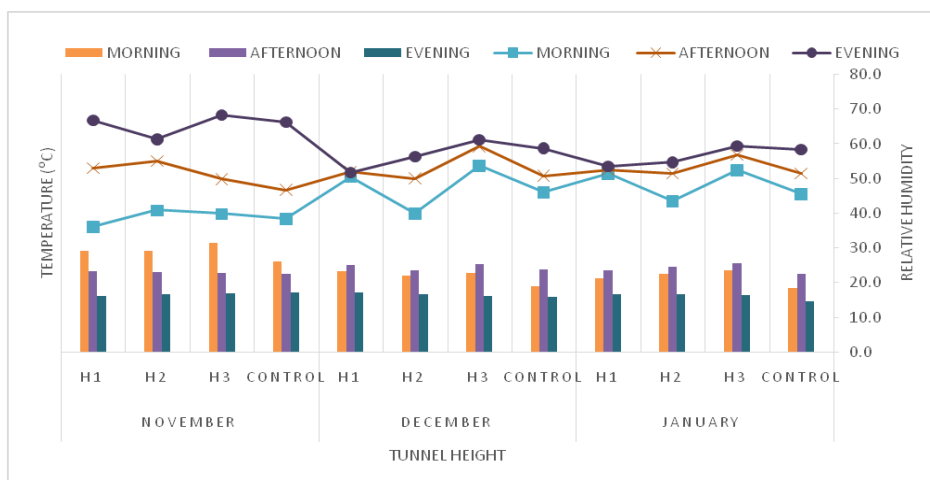
**Table.1** Analysis of variance (ANOVA), F value, P values and effect of low tunnel height, variety and interaction effects (low tunnel height x variety) on different plant characters on growth and yield characteristics of onion

Tunnel Height	Variety	PH	NL	DTH	FW	YPH(T)	SP	BuP	BD
H1	V1	43.00	2.663	114.33	22.667	7.01	19.477	20.483	1.267
H1	V2	32.70	5.333	116.33	17.807	12.07	33.297	37.880	3.000
H1	V3	24.30	2.663	106	24.667	4.08	12.113	13.043	1.467
H1	V4	24.10	4.667	107	15.227	3.78	30.587	32.320	2.867
H2	V1	27.1	2.330	118.66	25.333	20.30	12.983	13.110	1.467
H2	V2	36.0	5.333	119	19.837	11.29	34.727	53.993	3.767
H2	V3	21.60	3.110	102.66	41.667	5.10	31.163	30.590	2.800
H2	V4	23.60	4.333	104.33	19.760	6.30	31.160	44.410	3.500
H3	V1	47.00	2.887	113.66	29.667	20.02	41.120	41.700	2.267
H3	V2	48.70	5.000	97.66	32.227	21.65	65.673	66.497	3.933
H3	V3	25.20	3.220	103.66	44.333	6.67	31.160	33.443	2.767
H3	V4	21.60	6.333	107.33	26.593	7.11	53.943	80.467	3.667
Control	V1	32.5	3.107	117.33	34.667	20.61	35.373	36.073	3.133
Control	V2	34.00	5.000	117.66	37.373	19.67	38.050	35.177	4.500
Control	V3	28.5	2.887	109.33	35.667	7.76	27.143	26.323	3.567
Control	V4	19.4	4.333	106.66	34.140	9.63	11.553	07.267	4.167
<b>Tunnel Height</b>	F Value	11.545	4.432	657.74	64.68	221.281	45.491	2.348	98.067
	P value	0.0071	0.0581	<b>0.0001</b>	<b>0.0001</b>	<b>0.0001</b>	<b>0.0001</b>	0.1720	<b>0.0001</b>
<b>Variety</b>	F value	79.925	73.735	59.86	53.91	362.028	346.378	1.897	200.963
	P value	<b>0.0001</b>	<b>0.0001</b>	<b>0.0001</b>	<b>0.0001</b>	<b>0.0001</b>	<b>0.0001</b>	0.1570	<b>0.0001</b>
<b>Tunnel Height X Variety</b>	F value	7.394	3.146	93.350	2.860	26.027	24.114	1.113	4.901
	P value	<b>0.0001</b>	0.0121	<b>0.0001</b>	0.0191	<b>0.0001</b>	<b>0.0011</b>	0.3910	<b>0.0011</b>

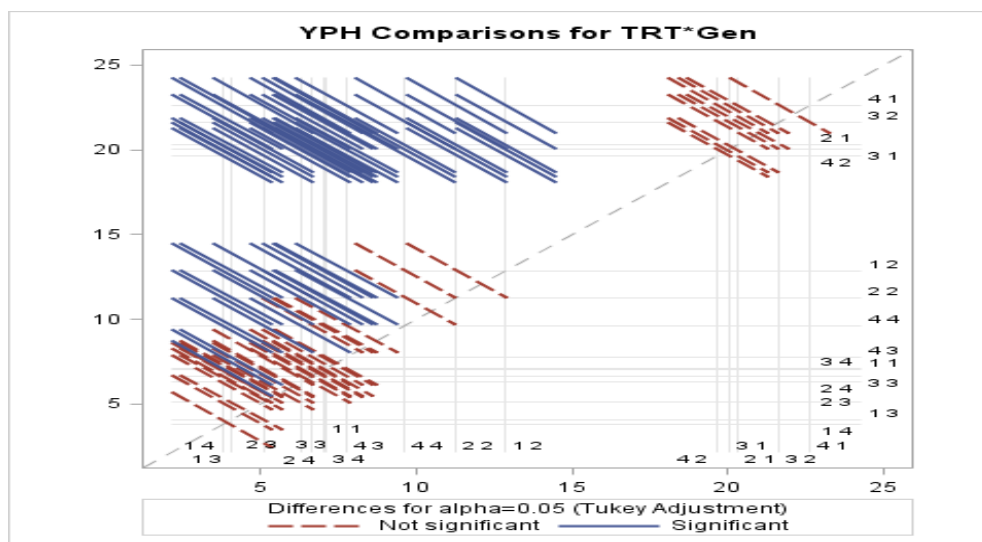
**Fig.1** Microclimate data under the different tunnel height and control condition during experiment



**Fig.2** Microclimate data under the different tunnel height and control condition during experiment



**Fig.3** Diffogram showing significant differences between the tunnel heights and onion varieties. The small line passing through the square diagonally represents no significant or significant differences between the corresponding interactions of Tunnel heights and onion varieties



Minimum days to harvest (105.41) was recorded in the variety “Minar” and maximum days to harvest was recorded in the variety F1 hybrid Rani. Similarly, significantly higher values for fresh weight (33.21 g), yield per hectare (13.86), Survival percentage (47.97) and Bulb diameter (3.84 cm) were also recorded at 100 cm low tunnel height and minimum of fresh weight (20.09 g), yield per hectare (6.74), Survival percentage (23.87) and Bulb diameter (2.15 cm) at 75 cm low tunnel height. Bulbing

percentage was not significantly affected by tunnel height. Result also shows that there was a significant difference for fresh weight, yield per hectare, Survival percentage and Bulb diameter. Maximum fresh weight (36.58 g) was recorded in the variety “Minar” and minimum was recorded in the variety leader (23.93 g). similarly maximum yield (16.99 t) was recorded in the variety F1 hybrid “Rani” which was at par with the variety “Nasik red” (16.17) and minimum yield was at the variety “Minar” (5.90 t). However, the maximum

survival percentage (42.94 %) and bulb diameter (3.80 cm) was recorded in the variety “Nasik red” and minimum survival percentage (25.39) at the variety “Minar” and bulb diameter (2.03 cm) at F1 hybrid “Rani”.

### **Interaction effect**

The interaction effect of low tunnel heights and varieties were found to be significant. The maximum plant height was observed in the main interaction of effect of 100 cm tunnel height and onion variety “Nasik red” (48.70 cm) which was at par with 100cm tunnel height and F1 hybrid “Rani” (47.00 cm) and minimum plant height (19.40 cm) was observed in the variety “Leader” (19.4 cm) as control (open) condition. Maximum number of days to harvest (123.66) was recorded in the main interaction of effect of 90cm tunnel height and the variety F1 hybrid “Rani” and minimum (97.66) was recorded in 100 cm tunnel height and onion variety “Nasik red”. Yield per hectare (21.65 t) and survival percentage (65.67%) was recorded as highest in the interaction effect of 100cm tunnel height and “Nasik Red” and the minimum Yield per hectare (3.78 t) in 75cm tunnel height and the variety “Leader” and minimum survival percentage (11.55 %) was recorded in variety “Leader” which was grown as control (open) condition. The maximum bulb diameter was recorded in the variety “Nasik red” which was grown in open condition and the minimum was recorded in the main interaction of 75cm tunnel height and the variety hybrid “Rani”. Significant differences between treatment interaction were graphically represented by diffogram using PROC GLM SAS (SAS Institute, Version 9.2) (Fig 2).

The present investigation shows that the increase in plant height was observed in the tunnel height over open condition due to increase in temperature inside the low tunnel. Higher air temperature was observed in this

experiment inside the low cost low plastic tunnel relative to control as open condition which encouraged vegetative growth and development at the beginning initial stage of the crop. The same result shows the increases in height and stem diameter of the crops grown under tunnel and mulched have been found much more than control plants (Levent and Sözer, 2001). Tressen (1983) also reported that critical soil temperature is 14°C for tomatoes and the development stops or becomes slowly below this temperature. Gerber *et al.*, (1988) reported that the pepper crop development increases by the increases of soil temperature due to tunnel effect. The results are in accordance with the findings of Pimpini *et al.*, (1987) who have observed that low tunnel and transparent polyethylene mulch increases the earliness in two tomato varieties. Tressen (1983) also recorded earliness and more yield with the 1-2 °C increase in temperature by the use of mulch. Yield per hectare, survival percentage, bulbing percentage and bulb diameter was recorded as highest in the interaction effect of 100cm tunnel height and Nasik Red which were due to increases the net photosynthesis and production of more assimilates available for individual to grow. Vegetative growth was greatest in plants in the tunnel where the thermal condition were best early and total marketable yield were highest under the poly tunnel (Ashish *et al.*, 2019).

The necessity for adoption of novel vegetable growing in low cost low plastic tunnel during snowfall condition in north Sikkim during October to April month of the year has been the most important issue in the present agricultural production systems. The main challenge is to grow the vegetable crops by use of low cost low plastic tunnel. Low tunnel facilitate the entrapment of carbon dioxide, thereby enhancing the photosynthetic activity of the plants and hence the yield. These structures also protect the plants from the high winds, rain, frost and snow. Besides being

inexpensive, they are easy to construct and dismantle. Low tunnels are being used for producing high quality, high valued nurseries and crops such as tomatoes, cucumber, radish, beans and capsicum (Lodhi *et al.*, 2015). Monteiro *et al.*, 2002 also carried out a study on perforated plastic film for low tunnels cultivated with lettuce without lettuce, with 0, 5, 10, 15 and 20% of perforated film area and in soil without tunnel. In conclusion, the present study can state that onion variety Nasik Red can raised in low cost low plastic tunnel height of 100cm for restricting overwinter in Sikkim condition.

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