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Off-Season Seedling Production of Sikkim Local Cucumber (*Cucumis sativus*) under Polytunnel of Different Heights

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ABSTRACT

The present study was conducted by Dept of Horticulture, Sikkim University, Gangtok at Nandok village, East Sikkim, Sikkim during 2015-2016 with the objectives to compare the effect of different dates of sowing and different height of poly-tunnel on cucumber seedling growth and to compare the morphological and physiological behavior of seedlings under poly-tunnel and open field conditions. The seeds of local cucumber were collected from Nandok village, East Sikkim. The raised bed of 3 m long, 1 m wide and 15 cm height were prepared before constructing the frame structure over it. The sowing was done on 15th December, 1st January and 15th January under open condition, 2.0 ft, 2.5 ft and 3 ft polytunnels and altogether twelve treatments were done with three replications under CRD. The highest average temperature range throughout the growing period of cucumber seedlings was recorded in treatment T_{10} (20-24^{0}C) i.e., 15th January sowing in 2.5 ft poly-tunnel. Temperature played significant role in germination of seed and establishment of seedlings. The treatment T_{10} (15th January+2.5 ft polyhouse) was observed to be best having germination % (72%), minimum days needed for transplanting of seedlings (34), maximum number of seedlings (25), maximum height of seedlings (12.5 cm), leaf area (57 cm²), net photosynthetic rate, transpiration rate and stomatal conductance (26.2 µmol/m²/s, 8.8 mmol/m²/s, 1.13 mmol/m²/s) respectively. The significant difference was observed in polytunnel as compared to control (open field). The advancement of nearly one month in harvesting of cucumber is able to fetch higher returns to growers and is beneficial to them.

Keywords Local cucumber, Offseason, Polytunnel, Sikkim, Temperature.

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INTRODUCTION

The total area and production of Horticulture crops in India is 311.71 million tonnes and 25.43 million hectares according to NHB (2018). Vegetables are being produced nationally from 10.26 million hect-

ares in area with 184.40 million tonnes in production. In Sikkim vegetable production accounts an area of about 26.1 (000'HA) under vegetables, 134.5 (000'MT) in production and have a productivity of about 5.2 MT/HA. Vegetable growing is one of the important branches of horticulture from economic point of view as well as nutrition point of view. The area of cucumber production in our country is presently 0.082 million hectares with production of 1.260 million tonnes.

Cucumber (*Cucumis sativus*) is a member of the family Cucurbitaceae and it is the main summer crop cultivated in the sub-himalayan state of Sikkim. It is one of the oldest vegetable crops grown widely throughout the country, tropical and sub-tropical parts of the world. It is probably indigenous to North India and from here it was introduced in Asia and Africa, and then in Europe (Singh *et al.* 2013). It is known as "Khira" in Hindi and "Kaakra" in Nepali is a very popular and important vegetable grown in hills and plains in India. It is 2nd most widely cultivated cucurbit after water melon. It is also cultivated in North Eastern Hill states like Arunachal Pradesh, Nagaland, Mizoram, Manipur, Meghalaya, Assam and parts of Uttarakhand.

The tiny himalayan state of Sikkim is endowed with diverse climatic conditions and where high mountains offer steep environmental gradient and wide distribution and adaptation of local landraces. A local landrace of cucumber with typical characteristics is unique in terms of length, color, weight, taste and utility of fruit. It is used not only as salad but also used as vegetable and processed as pickles by local communities. Mostly the small fruits are used for pickling and big fruits are used for salads and for cooking purposes. The fruit which is eaten raw with salt and pepper at the immature and mature stages. It is available in State of Sikkim markets during June to September depending upon elevation but fetch less price as compared to other improved varieties (Denzongpa *et al.* 2015).

The cucumber plant is a trailing or climbing annual, bearing elongated, thick cylindrical fruits of varying sizes and forms. The cucumber seed has a pleasingly crisp texture and subtle flavor but a slightly bitter taste. The plants are monoecious bearing male and female flowers. The flowers do not open at temperature below 12^0C; dehiscence and nectar secretion begins at 160-17^0C. The optimal temperature for germination of cucumber is 24^0C-28^0C (Nowicki *et al.* 2013). Cucumbers are mostly pollinated by honey bees. The plants produce only female flowers and seed of monoecious lines are mixed at the time of sowing for providing male flowers for pollination purpose. It is a warm season crop and cannot tolerate even a slightly lower temperature. The best temperature for its growth is 27^0C– 35^0C. High humidity and high temperature are not suitable for better fruit set. As similar to other cucurbit crops cucumber has presence of cucubitacin. Its fruits have a cooling effect and prevent constipation and are useful in jaundice and other diseases. Its edible portion contains 93.6 % water, 2.7% CHO, 0.4% proteins 0.1% fat, 0.4% minerals and is a good source of vitamin B and C too.

A polytunnel is a tunnel made of polyethylene, usually semi-circular, square or elongated in shape. Polytunnels are used to provide a higher temperature and/or humidity and are able to protect crop from outside adverse weather conditions. Polytunnels are mainly used in temperate regions in similar way to greenhouses but are comparatively made in lower cost. They are used to grow offseason vegetables also. Bharali and Singh (2020) reported that polyhouses are ideally suited for raising nurseries of vegetables both sexually and asexually. Polyhouses are very well suited for farmers having small holdings and the management of insects, pests is also easy. In polyhouses, organic farming of vegetables is easy. Goyal and Sharma (2021) reported that practice of growing cucumber in polyhouse has been adopted worldwide. Navnath *et al.* (2019) reported that in the North-Easten India, greenhouses are being used as rain shelters to promote offseason vegetable cultivation. In the northern plains, vegetables seedlings are being grown under protected cultivation for improving quality of seedlings as well as capturing the early markets.

The exact time for direct sowing of cucumber seeds by Sikkim farmers is from last week of February to entire month of March. It would be very much beneficial or economical for farmers to fetch

more returns from crop if they could sow seed first in polytunnel in December or January and after that transplanting in main field is done later. In this way, if harvesting time is advanced by one month and local cucumber reaches little earlier to the consumers e.g. April-May instead of June month, it is sure that growers will get more economic returns. Keeping in view the above mentioned points, the present study was undertaken with the objectives to compare the effect of different dates of sowing and different height of polytunnel on cucumber seedling growth and to compare the morphological and physiological behavior of seedlings under polytunnel and under open field conditions.

MATERIALS AND METHODS

The present research work was carried out during the year 2015-16 in the field (polytunnel and open field) of Nandok village, East Sikkim, Sikkim at an altitude of 3720 ft and with latitude N 27^0 17.635' and longitude E 88^0 36.065'.The details of materials used and methodology employed during the course of investigation have been described in this section.

Collection of seeds of local cucumber: About 100-200 g of seeds of local cucumber was collected from different farmers of Nandok village, East Sikkim.

Preparation of raised bed and construction of polytunnel: The raised bed of 3 m long, 1 m wide and 15 cm height were prepared before constructing the frame structure over it. The frame structure of poly-tunnels were constructed by using local bamboo collected from nearby field and made them into number of small splints of length 2.5 m, 3.5 m and 4.5 m for 2 ft, 2.5 ft and 3.0 ft respectively. For each poly-tunnel 7 splints were used for construction of frame. The bamboo splints were arched and augured in soil at both the ends. Approximately 10 nos (ghana) of bamboo were used for construction of 9 poly-tunnels.

Sowing of seeds and covering of polytunnels: After the final construction of poly-tunnel, black polythene bags of dimensions: 5" × 5" × 10" and capacity 1 gal filled with equal quantity of soil, FYM and sand were placed inside the polytunnel. Overnight soaking of seed was done prior to sowing to enhance germination percentage. For each treatment 10 poly bags were placed with equal spacing and in each polybags 5 seeds were sown in 3 different dates, i.e., 15th December 2015, 1st January and 15th January 2016. After sowing polytunnels were covered by transparent Low Density Polyethylene (LDPE) films of 30 µ thickness. The sides of the plastics were tied on the peg at both the sides of the tunnel and firmly kept in place by filling the earth around them. Regular inspections were carried out for checking weeds and watering was done at 2-3 days interval till the seedling establishment.

Instruments used: The instruments used in the research work were CI-340 Handheld Portable Photosynthesis System, Leaf Area Meter, Measuring Scale (30 cm) and Manual Thermometer.

Observations recorded

Mean temperature during the growing period: Temperature inside the polytunnels and open field were recorded from 15th December 2015 to 1st January 2016 at 15 days interval by placing the thermometer inside the polytunnel and for open field, the data source was from Indian Meteorological Department (IMD), Gangtok Branch and the mean value were calculated and analyzed.

Germination percentage (%): Germination percentages was calculated by using the following formula: - Germination percentage (%) = No. of seeds germinated / Total No. of seeds sown × 100. Fifty seeds were sown for each treatment studied.

Number of days taken for germination: Number of days from sowing of seed till the germination was recorded by visual observation.

Number of days taken for transplanting at 4-5 leaf stage: Numbers of days from seed germination till transplanting of seedlings were recorded by visual observation.

Number of seedlings transplanted: Uniform and healthy seedlings at 4-5 leaf stage were actually transplanted from each treatment.

Height of seedlings before transplanting: Seedlings which are ready for transplanting were measured by 30 cm measuring scale.

Leaf area before transplanting: Leaf areas of seedlings were measured with the help of Leaf Area Meter before transplanting.

Net photosynthetic rate (Pn)transpiration rate (E) and stomatal conductance (C) in leaves before transplanting: Net photosynthesis rates (Pn) (µmol/m²/s), Transpiration rates € (mmol/m/s), Leaf stomatal conductance (mmol/m²/s) were measured with CI-340 Handheld Portable Photosynthesis System. The leaf from second node was selected for measuring the observations and the mean value was calculated and analyzed.

Details of treatments and statistical analysis: The total of following twelve treatments with three replications were analyzed using CRD (Completely Randomized Design): T_0 (15th December+ open field (control)), T_1 (15th December+ 2.0 ft poly-tunnel), T_2 (15th December+ 2.5 ft poly-tunnel), T_3 (15th December +3.0 ft Polytunnel), T_4 (1st January+open field (control), T_5 (1st January+ 2.0 ft Polytunnel), T_6 (1st January+2.5 ft Polytunnel), T_7 (1st January+3.0 ft Polytunnel), T_8 (15th January+open field (control), T_9 (15th January +2.0 ft. Polytunnel), T_{10} (15th January+2.5 ft Polytunnel), T_{11} (15th January+3.0 ft).

RESULTS AND DISCUSSION

This section deals with the experimental findings obtained during the course of investigation.

Mean temperature during the growing period: The total growth period needed for establishment of seedlings sown on different dates and in different heights of polytunnels and open field conditions was nearly three months, i.e., from 15th December 2015 to 15th March 2016 (Table 1). There was no significant difference observed on variation of temperature in between the different heights of poly-tunnel at different time interval. There is highly significant difference found in between the open field and the polytunnels at every 15 days interval. Within the poly-tunnel the highest temperature was recorded in 2 ft poly-tunnel from 1st March to 15th March 2016 (24.21^{0}C) and the lowest temperature was recorded in 3 ft poly-tunnel from 15th December to 1st January (16.85^{0}C). The average temperature during the entire growth period was found highest in 2 ft poly-tunnel (20.97^{0}C) followed by 2.5 ft poly-tunnel (20.38^{0}C) and 3ft poly-tunnel (19.81). An average temperature recorded in open field was 10.05^{0}C which was found lower than all the three different heights of poly-tunnel. The results of present study revealed that in poly-tunnel 9-10^{0}C higher temperature was recorded as compared to open field. The present result was similar to the observations of Cheema *et al.* (2014) who observed 4-9^{0}C more temperature in polytunnel of 3 ft height as compared to open field. The present study revealed that there is more possibility of producing quality planting material in winter months because of better microclimate inside the polytunnel as compared to open field to fetch better returns by raising early crop and disease free seedlings in offseason as observed by Yadav *et al.* (2014). Suresh *et al.* (2022) reported in their study that cucumber is a thermophilic and frost susceptible crop and temperature above 20^{0}C is favorable for cucumber cultivation in polyhouse.

Table 1. Average temperature during the growth period.

Fortnightly average temperature under poly-tunnel and open field from 15th December 2015 to 1st January 2016 in ^{0}C				
Fortnightly interval	Open field (control)	2.0 ft Poly -tunnel	2.5 ft Poly-tunnel	3.0 ft Poly-tunnel
15th Dec 2015 to 1st Jan 2016	7.23	17.69	17.43	16.85
1st Jan to 15th Jan 2016	8.92	19.42	18.61	17.72
15th Jan to 1st Feb 2016	9.46	20.26	19.86	18.36
1st Feb to 15th Feb 2016	10.32	21.22	20.82	19.42
15th Feb to 1st March 2016	11.22	23.02	21.82	20.52
1st March to 15th March 2016	13.18	24.21	23.78	22.2
Average temperature	10.05	20.97	20.38	19.17
CD at 5 %	=3.17			

Germination percentage (%): The data presented in Table 2 showed significant difference at 5% level

Table 2. Observations on cucumber seedlings before transplanting. * NR= No result.

Treatments	Germination %	Days taken for germination	Days taken for transplanting	No. of seedlings transplanted	Height of seedlings (in cm)	Leaf area (in cm²)	Pn (µmol/m²/s)	E (mmol/m²/s)	C (mmol/m²/s)
T_0 (15th Dec+open field) control	NR	NR	NR	NR	NR	NR	NR	NR	NR
T_1 (15th Dec+2.0 ft)	18	15	59	4	11.9	46.7	18.6	2.6	0.4
T_2 (15th Dec+2.5 ft)	22	16	62	5	11.8	55	21.23	4.2	0.6
T_3 (15th Dec+3.0 ft)	24	17	65	7	12.2	49.2	23.2	5.4	0.6
T_4 (1st January+open field) control	12	25	60	3	12.4	51	14.2	0.9	0.2
T_5 (1st Jan+2.0 ft)	36	9	41	8	12.2	54	19.26	4.3	0.6
T_6 (1st Jan+2.5 ft)	40	10	46	11	10.5	51.5	23.6	5.6	0.7
T_7 (1st Jan+3.0 ft)	46	11	47	15	11.6	52	24.4	6.2	1
T_8 (15th Jan+open field) control	16	20	50	4	12.2	46	16.4	1.3	0.3
T_9 (15th Jan+2.0 ft)	60	5	37	17	11.5	54	24.4	6.69	0.8
T_{10} (15th Jan+2.5 ft)	72	6	34	25	12.5	57	26.2	8.8	1.13
T_{11}(15th Jan+3.0 ft)	68	7	37	20	11.4	54	25.4	7.9	0.9
GM	34.50	11.75	44.83	9.91	11.85	47.53	19.71	4.49	0.60
SE(m)	1.067	0.68	0.89	0.89	1.09	0.97	1.18	0.11	0.10
CD at 5%	3.11	2.0	2.61	2.61	3.18	2.83	3.46	0.33	0.32

of significance in germination percentage of seeds. Altogether 50 seeds were taken per treatment. The treatment T_{10} (15th January+2.5 ft) showed highest germination percentage of 72% and the lowest germination percentage was recorded in treatment T_2 (16 %) which was found statistically at par with treatment T_1 (18%). There was highly significant difference found in between all the treatments ranging from T_0 to T_{11} except between the treatments T_3 (24%) and T_2 (22 %). In T_0 no germination was observed. The variation in seed germination percentage in treatments might be due to difference in temperature throughout the growing period. Starting from 15th December to 1st March till the seedlings establishment the temperature recorded was in optimum range for germination of seeds of cucumber (19–23^{0}C). Singh *et al.* (2017) also reported that cucumber is a thermophilic and frost susceptible crop and grows best at temperature above 20^{0}C. As reported by Dhaliwal (2017) the seed germination of cucumber is best when temperature ranges between 25–30^{0}C.

It was observed that treatment T_0 in which seeds were sown in 15th December in open field failed to germinate due to low temperature. The temperature range recorded from 15th December to 15th January was (7.23–8.92^{0}C). Likewise minimum germination percentage was observed in T_4 which also falls under seeds sown in open field but the sowing date was 1st January and the temperature range recorded was (8.92–10.32^{0}C) from 1st January to 1st February but seeds germinated below the minimum range. It was also observed by earlier workers that variety sown also influenced germination.The difference in germination percentage was only due to the variation in temperature within the polytunnels and open field.

Number of days taken for seed germination: The observations regarding the average days taken for seed germination have been presented in Table 2. The treatment T_9 (5) showed minimum days taken for seed germination which was found statistically at par with T_{10} (6), T_{11} (7), T_5 (9), T_6 (10) and T_7 (11). The significant difference was found in between the treatment T_4 (25), T_8 (20) and T_3 (17) and also between T_2 (1) and T_7 (11). There was no result observed in T_0 (control). The maximum days were taken by T_4 (25) which was found significantly different with treatment T_8 (20) and T_3 (17). The treatment T_9 showed average minimum days needed for seed germination i.e. 5 days inside 2 ft polytunnel on 15th January sowing and in that period the average temperature ranged between (20.26 ^{0}C–21.22^{0}C). Pothour (2017) also mentioned about optimum germination of cucumber

at 20^0C (68^0F) and minimum number of days required were 6.2. Likewise the maximum days needed for seed germination was observed in T_4 (25) i.e., in open field condition on 1st January sowing. It was because of the low temperature range during that period (8.92^0C -10.32^0C) and below 15^0C temperature the germination. Pothour (2017) also mentioned that at 15^0C (59^0F) the days needed for seedling emergence of cucumber was 13 days. By comparing the maximum and minimum days, importance of temperature for germination of cucumber was observed.

Number of days taken for transplanting at 4-5 leaf stage: Average numbers of days taken for transplanting of seedlings at 4-5 leaf stage for treatments ranged from T_0 to T_{11} were found to be significant at 5% level of significance as mentioned in Table 2. The minimum days taken for transplanting of seedlings was recorded in treatment T_{10} (34) which was observed significantly different to the treatment T_{11} (37). There was no significant difference found between the treatments T_2 (62), T_3 (60) and T_9 (37) , T_{11} (37). From present data the minimum days recorded for transplantation of seedlings was 34 days from germination in treatment T_{10} (15th January sowing in 2.5 ft poly-tunnel) which was found nearly similar to the data presented by Denzongpa *et al.* (2015) in which the 1st week of January sown seeds were ready for transplanting by 1st fortnight of February at 4 leaf stage. So it is obvious that there might have been difference in temperature inside the polytunnel and open field in present study and which could have affected number of days taken for transplanting. The treatment T_{10} was found to best treatment for number of days taken for transplantation of seedlings at 4-5 leaf stage.

Number of seedlings transplanted: Maximum average seedlings were transplanted from treatment T_{10} (25) followed by T_{11} (20) and T_9 (17) and they were found significantly different to each other (Table 2). Minimum average seedlings were transplanted from treatment T_4 (3) and were found significantly at par with treatments ranging from T_1 (4) to T_6 (11). The minimum seedlings establishment was recorded in seeds sown in 1st January in open field because during the seedling establishment period the temperature range was between (8.92^0C–11.22^0C). The lower temperature and longer duration increases the chilling injury. Chilled plants can survive but they are not able to develop properly. Low temperature is a crucial environmental factor that limits the development and productivity of cucumber crop. Low temperature reduces the net NO_3- flux rate in the root hair zone and vascular bundles of cucumber seedlings, whereas the net NH_4 + flux rate was enhanced in vascular bundles of mid rib, lateral vein and shoot tip (Liu *et al*. 2021). The reduction is seedling establishment might be due to chilling injury in open field than the polytunnel that is why the number of seedling established were maximum inside the polytunnel than the open field and also the planting time. The little difference found between the different heights of polytunnel might be due to difference in temperature inside the polytunnel. The treatment T_{10} was found best in average number of seedlings actually transplanted.

Height of seedlings before transplanting: Average height of seedlings before transplanting for treatments ranged from T_0 to T_{11} were found to be significant at 5% level of significance (Table 2) showed that maximum seedlings height was observed in treatment T_{10} (12.5 cm) followed by T_4 (12.4 cm) and T_3 (12.2 cm). Minimum height was recorded in treatment T_6 (10.5 cm). The entire treatments were found to be statistically at par with each other. There was not much difference found in between the different treatments in average height of seedlings before transplanting. The slight difference may be because of fluctuation in temperature within the polytunnel and the open field.

Leaf area before transplanting: Among the twelve treatments evaluated T_{10} (57 cm^2) showed maximum leaf area followed by T_2 (55 cm^2) and T_5 (54 cm^2) were found to be at par with all the remaining treatments except T_0 (Table 2). The minimum leaf area was observed in T_8 (48 cm^2). There was not much difference found in between the treatments in leaf area as compared to height of seedlings. The seedlings were transplanted at 4-5 leaf stage which were found nearly similar to each other. It can be concluded that as the height of seedlings were nearly similar to each other then the leaf area was also expected to be similar and all the seedlings were transplanted at similar leaf stage and the difference was only in days

needed from sowing to transplanting.

Net photosynthetic rate (Pn), Transpiration rate (E), Stomatal Conductance (C)) in leaves before transplanting: The present data pertaining that the net photosynthesis rate (Pn) in different treatment showed that they were statistically at par with each other except T_0 (Table 2). T_{10} (26.2 µmol/m²/s) was recorded for maximum net photosynthesis rate as compared to all the other treatments. Minimum net photosynthesis was recorded in T_4 (14.2 µmol/m²/s). The same treatment T_{10} (8.8 mmol/m²/s) showed higher transpiration rate followed by T_{11} (7.9 mmol/m²/s) and T_9 (6.69 mmol/m²/s). There was least significant difference observed between all the treatments except T_6 (5.6 mmol/m²/s) and T_3 (5.4 mmol/m²/s) and also between T_5 (4.2 mmol/m²/s) and T_2 (4.2 mmol/m²/s). Minimum transpiration rate was recorded in T_4 (0.9 mmol/m²/s). Highest stomatal conductance was recorded in treatment T_{10} (1.13 mmol/m²/s) followed by T_7 (1.0 mmol/m²/s) and T_{11} (0.9 mmol/m²/s). Least stomatal conductance was recorded in treatment T_4 (0.2 mmol/m²/s). The data presented revealed that there was no significant difference found between all the treatments (Table 2).

Ouzounidou *et al.* (2016) observed net photosynthetic rate, transpiration rate and stomatal conductance in two varieties of cucumber in open field. They observed that maximum and minimum net photosynthetic rate was (20.0 µmol/m²/s, 16 µmol/m²/s), maximum and minimum transpiration rate (5 mmol/m²/s, 4 umol/m²/s), maximum and minimum stomatal conductance (0.8 mmol/m²/s, (0.6 umol/m²/s). There was little difference found in between the findings of Ouzounidou *et al.* (2016) and present study and it might be due to difference in planting time height of polytunnel as compared to open field.

From the above findings, less variations were observed in different parameters within the different height of polytunnel on different dates of sowing but there was highly significant variation found in between the seedling established inside the polytunnel as compared to the open field. Through the present study seedlings from T_{10} (15th January+2.5 ft) showed superiority in all the parameters except in average minimum days needed for seed germination where T_9 (15th January+2.0 ft) performed best. Therefore from present study it was concluded that the seedlings that were developed from 15th January sowing under 2.5 ft polytunnel were found early, uniform and healthy as compared to all the other seedlings that had been developed from 2 ft and 3 ft and also from open field. The germination percentage, survival of seedlings under low temperature during winter months was found maximum in T_{10}. Due to the maximum survival and healthy seedlings obtained from T_{10} there are ample chances of best yield that can be obtained from these offseason seedlings. They can also fetch better economic returns to the marginal farmers and they can be promoted for commercial cultivation over larger area. The findings of Thakur and Mayanglambam (2023) and Denzongpa *et al*. (2015) support the offseason cultivation of cucurbits. Denzongpa *et al.* (2015) had reported significant difference in cost benefit ratio of 1:4.6 of early transplanted cucumber seedlings as compared to 1:2.7 of seedling transplantation at usual time. Kumar *et al.* (2015) recommended that the yield of cucumber and income of farmers can be increased by adoption of polyhouse technology. As per their findings, farmers realized 145.32% higher yield of cucumber under polyhouse as compared to open field conditions. Pal *et al.* (2020) also emphasized that protected cultivation of cucumber ensures higher productivity and superior quality than open cultivation. The root system of young seedlings may be damaged and growth restricted if soil temperature is low.

Banoo *et al.* (2024) in their review study on tomato performance in a protected structure have mentioned that protected structure defends tomato fruit from biotic and abiotic stress in offseason also. It also increases yield, quality, shelf life and also helps in year round availability of tomato. Stable income has been reported in this study as compared to open field conditions.

The main factor that played a crucial role in survival of seedlings in winter months under polytunnel was temperature. As it is well known that cucumber is warm season crop it cannot tolerate frost. Therefore, in order to protect the plant from severe frost during the winter months, temperature may be increased for seedling establishment thereby minimizing the

harvesting time and fetching better returns from off-season crop under low cost polytunnel. This would be the best agro-technique for cucumber cultivation in hilly areas.

CONCLUSION

The significant difference was observed in polytunnel as compared to control (open field) in case of local cucumber seedlings. The treatment T_{10} (15th January+2.5 ft polyhouse) was observed to be best having germination % (72%), minimum days needed for transplanting of seedlings (34), maximum number of seedlings (25), maximum height of seedlings (12.5 cm), leaf area (57 cm^2), net photosynthetic rate, transpiration rate and stomatal conductance (26.2 µmol/m^2/s, 8.8 mmol/m^2/s, 1.13 mmol/m^2/s) respectively. The advancement of nearly one month in harvesting of cucumber is able to fetch higher returns to growers and is beneficial to them. The study is quite important regarding commercial large scale nursery production of local cucumber seedlings.

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