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Influence of microclimate condition of under low tunnel on productive responses in bitter gourd (*Momordica charantia*)

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ABSTRACT
Bitter gourd production under low tunnels has spread in recent years. However, there is little information on the productive responses of bitter gourd grown under low tunnel. A field experiment was conducted to determine the effect of date of sowing and growing condition to get early harvest of Bitter gourd var. Arka Harit at farm source. The experiment was laid in randomized block design with seven treatments in three replications. The treatments comprised the seven dates of sowings i.e., 30th November under open field, 15th December under open field, 30th December under tunnel, 15th January under tunnel, 30th January under tunnel, 15th February under open field and 28th February under open field. Result was found to be significant in most of the growth, flowering and yield contributing parameters of Bitter gourd. Fruit length (12.70 cm), fruit girth (7.32 cm), fruit weight (093.40 kg), fruit per plant (13.50, yield per plant (1.260 kg), yield per hectare (221.25 quintal), net income (Rs. 129900) and cost benefit ratio (1:2.15) were maximum while number of days taken to first female flower, incidence of red pumpkin beetle and first harvest was minimum when the date of sowing was 30th December under low tunnel condition (T_3) over other date of sowing under low tunnel. The result suggest that low tunnel in bitter gourd increases fruit yield and improves precocity due to raised temperature during flowering stage and fruit set. The Bitter gourd has high market value in off-season, so when crop sown on 30th December under low tunnel, farmers can get more profit by adopting this technique.
Key Words: *Off-season, Low Tunnel, Date of Sowing, Profit, Bitter gourd.*

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INTRODUCTION

Among the various cucurbits, Bitter gourd (*Momordica charantia*) is one of the excellent fruit that are required for good health and quality human life which is commonly known as balsam pear or bitter melon. It is tropical and subtropical crop belong to cucurbitaceae family which is widely grown in Asia and Africa. Bitter gourd is originated in India. It reduces the blood sugar level and is very good for good for diabetic patients. So round the year bitter gourd is demanded vegetable crop in India. Therefore it can be successfully grown in low tunnels. Growing of bitter gourd in low tunnels makes it possible to produce the crop approximately 4-6 weeks earlier than field grown bitter gourd. When added to other vegetables grown in low tunnels, bitter gourd will increase marketing opportunities, improve early cash flow, and complement other high tunnel crops like tomatoes. Bitter gourd is grown well during warm season in India. Where there is a good scope of its export to developed countries and also to developing countries. Plastic low tunnel provide a cheap and better way for off-season cultivation of cucurbits production. Studied conducted in tomato and strawberries indicate that the increase in temperature tunnel directly influences fruit precocity (Jorge *et al*, 2015). Seedlings are raising in pro- tray and crop production inside tunnel gaining popularity among the farmers. To mitigate the possible impact of climatic change on vegetable production as well as on national economy, several initiatives have been undertaken. The fruits remain available from December to February, thus causing glut in market, which lead to price crash in the main season (Kumar *et al*. 2015). But the price of the produces have high premium value during their off-season availability by adopting the season forcing techniques like green house, poly house net house and low tunnel (Enoch and Enoch, 1999) but installation of these structures are costlier so unaffordable by the small and marginal farmers. Out of these techniques, low tunnel is found one of the best for non woody species, such as ornamental and vegetable (Zhao *et al*. 2014). The low tunnel could be increasingly necessary to mitigate adverse effects of climate change on fruit growing (Carlen and Kruger, 2009) With the use of low cost protected structures such as row covers or plastic tunnel can protect the plants against low temperature during winter season and link the early market to get good return of crop produces (Lie *et al*. 2012). Studies have shown that air temperature inside the tunnel is 3 to 20^{0}C and soil temperature is 2-5^{0}C higher than that of open fields (Ogden and Van Iersel, 2009; Zhao *et al*. 2014) which can warm the soil and protect the plants from hails, cold wind, injury and advance the crops than normal season because temperature goes below 8 ^{0}C for30-40 days during winter season in plain of north India. Technology for cucurbits production has been extended to the farming community successfully. Farmers are gradually adopting different protected structure to combat the climatic vagaries and emerging challenges in vegetable production. They are also used to raise the quality seedlings of cucurbits in plastic pro-tray technique. In this respect there are three type of soilless rooting medium i.e. coco peat, perlite and vermiculite medium are required. Role of Coco-peat medium is improved porosity, drainage and air movement activity. Perlite having its role in to improve aeration and drainage is essentially expanded heat of aluminium silicate rock and white granular product whereas vermiculite is expanded heat of mica having good water holding capacity. Low tunnel or raw covers are flexible transparent miniature structures, which usually are 1meter width and 0.5 meter in height are installed over the rows or individual beds of transplanted vegetable to enhance plant growth. The low tunnel techniques can use for raising seedlings by modifying the microclimate (Ken-Bar 2004). Generally, the tunnels are made in north to south direction to receive maximum sunlight. Transparent plastic of 30-50 micron is commonly used for making low tunnels, which reflects infra-red radiation to keep the temperature of the low tunnels higher than outside. These tunnel increases the inside temperature and entrapment of carbon dioxide, resulted more photosynthetic activity of crops hence early produce. They create a favourable microclimate around the crops by proving, frost and pest protection and reducing moisture loss. (Butler and Ross, 1999). Keeping all the above facts in view, the proposed study was planned with the objective to find out best date of sowing and growing condition to get earliest produce for fetching higher price in market.

MATERIAL AND METHODS

The field experiment was conducted in winter season during 2009-10 & 2010-11 at vegetable research farm of the Bihar Agricultural College, Sabour, Bhagalpur, Bihar. Bhagalpur was situated in the plane of Ganga basin at height of 141feet above sea level with 25^o 15' 12.20''N latitude and 86^o 59' 20.61'' E longitude. The experimental site was characterized by subtropical climate in which temperature ranges from 4 ^{o}C to 28 ^{o}C during winter. The soil was sandy loam, well drained having pH 7.22, organic carbon 0.41%, available N 228.15 kg/ha, P_2O_5 49.25 kg/ha and available K_2O 363.78 kg/ha. The experiment was conducted in randomized block design in three replications with seven treatments. The treatments comprised the seven dates of sowings i.e., 30th November under open field, 15th December under open field, 30th December under tunnel, 15th January under tunnel, 30th January under tunnel, 15th February under open field and 28th February under open field. Seedling of Summer squash var. Australian Green was transplanted with spacing of 1 m x 0.5 m. For making plastic low tunnel, 60 cm width, 50 cm high and 50 micron transparent plastic were used, immature bamboo stick were pegged on the both sides of water channel. The tunnels were made in north-south direction and vents were made in tunnel on east side. All the necessary cultural practices were carried as per package of practices during the growth period of the crop. In day time plastics are removed from one side of the row and again recovered the row with plastic in the evening time to warm up the plant in presence of sunlight. Plastic of the tunnel was removed from the bed in the 2nd week of February in each year. The five plants were randomly selected in each treatment for recording various plant growth parameters and yield parameters. Mean values of different characters were used for statistical analysis. The data were recorded on first female flower appearance, first picking, fruit length (cm), fruit girth (cm) and fruits per plant. Mostly artificial soil media was used for raising healthy and vigorous seedlings of vegetable in plastic pro- trays. There were three ingredients viz., cocopeat, vermiculite and perlite which are being used as a rooting medium for raising the nursery. Benefit of this nursery was better root development of transplants and reduction in the mortality in transplanting of seedling as compared to the traditional system of nursery raising. Seedlings were raised by sowing seeds in plastic pro-trays which were filled with growing media prepared by mixing coco peat: vermiculite: perlite in the ratio of 3:1:1 (V/V). Seedlings were ready in about 20-25days. The fruits selected for recording fruit length were used for measuring fruit diameter in centimetres at middle periphery of fruits with the help of Verneer Callipers. The data generated for both growing seasons were pooled together and then analysed statistically (Panse and Sukhatme 1978).

RESULTS AND DISCUSSION

The impact of climate change is likely to have a great influence on the agriculture and eventually on the food security. Protected structures i.e., low tunnel can play important role to minimize the impact of temperature fluctuation over precipitation, fluctuating sun shine hour and infestation of disease and pest (Singh and Satpathy, 2005). Such analyses are being made to support the regional policies for making agriculture sector resilient to climate change. Inside the tunnels, plants got better growth as compared to open field. This might be due to the presence of favourable soil and air temperature which increases the better establishment of plants. Temperature difference is largely the result of heat radiation which is trapped by the row covers (Ibarra *et al*., 2001). Row covers increases air temperature around the crop and their use has been associated with increased plant growth (Akinci *et al*., 1999; Both *et al*., 2007; Rader and Karlsson, 2006 and Waterer and Bantle, 2000). The major results and discussion related to present research with different parameters are discussed below:

Table 1. Effect of sowing time and growing conditions on growth and yield attributing parameters of bitter gourd

Treatments	Female flower	First picking	Fruit length(cm)	Fruit girth(cm)	Fruits/plant	Fruit weight (g)	Yield/ plant	Yield/ha
T1=30th Nov. Open field	60.00	64.50	8.40	5.55	8.75	85.70	0.788	138.88
T2=15th Dec. Open field	62.50	71.50	8.80	5.42	6.60	71.40	0.471	54.86
T3=30th Dec. under tunnel	53.50	61.00	12.70	7.32	13.50	93.40	1.260	258.09
T4=15th Jan. Under tunnel	56.50	65.00	10.20	6.80	12.50	91.20	1.004	173.72
T5=30th Jan. tunnel	58.00	65.50	10.80	5.73	12.35	82.50	1.018	136.09
T6=15th Feb. Open field	55.50	63.50	10.35	7.10	10.35	91.70	0.040	33.79
T7=28th Feb. Open field	54.00	62.50	11.10	7.65	10.65	89.00	1.008	21.70
SD	1.67	1.87	0.33	0.25	0.48	2.66	0.03	7.76
CD at 5%	3.40	3.80	0.67	0.52	0.99	5.43	0.06	16.91

Table 2. Effect of sowing time and growing conditions on growth and yield attributing parameters of bitter gourd

Treatments	Vine length (cm)	Primary branch	Yield/ha	Net income	B: C	Incidence of red pumpkin beetle
T1=30th Nov. Open field	2.65	5.60	85.65	52.20	0.87	10.75
T2=15th Dec. Open field	2.00	5.10	63.30	10.58	0.17	9.97
T3=30th Dec. under tunnel	3.10	8.86	221.25	129.90	2.15	5.74
T4=15th Jan. Under tunnel	2.95	7.90	161.70	104.03	1.73	6.86
T5=30th Jan. tunnel	2.73	7.10	132.90	92.70	1.54	5.74
T6=15th Feb. Open field	2.75	8.30	140.10	80.93	1.35	18.86
T7=28th Feb. Open field	2.95	9.30	173.97	94.95	1.58	19.81
SD	0.10	0.32	2.80	5.35	0.07	0.72
CD at 5%	0.21	0.67	5.72	11.67	0.14	1.58

Flower attributing parameters

Days taken to first female flower appearance and first harvest were significantly influenced by the sowing date and growing conditions. Minimum number of days taken to first female flower and first harvest was observed when the sowing was done on 30th December under low tunnel (T_3) over other date of sowing under low tunnel. Tunnel forces the early harvest of crop which can earn high market value in off-season.

The favourable effect of low tunnel on flowering and harvesting might be due to the conducive microclimate condition through which crop had reached to early flowering and fruiting by increasing the temperature at that time. Ogden and van Iersel (2009) have also indicated that low tunnels modify climatic conditions, promoting earlier flowering and fruit ripening as well as fruit precocity production. In similar study conducted by Ibarra *et. al.* 2001 observed that muskmelon crop grown under plastic cover flowered 24 days earlier than uncovered plants.

Yield attributing parameters

Perusal of data presented in Table 1 and Table 2 revealed that fruit length, fruit girth, fruit weight, yield per plant and yield per hectare, fruit per plant were significantly influenced by the sowing date and growing conditions. Maximum fruit length, vine length, fruit girth, fruit weight, yield per plant, fruit per plant and yield per hectare were found when the sowing was done on 30th December under low tunnel (T_3) over other date of sowing under low tunnel. It might be due to better growth and development of all yield contributing parameters under low tunnel which increases the net photosynthesis and production of more assimilates available for individual to grow. Similar results were also given by Singh *el al* (1989). It is important to note that no significant differences were observed in fruit weight in both condition i.e., grown in tunnels and in open field. Singh *et al* (2012) who indicated that the HR is higher in crop under tunnel than in open fields. It is important to note that a high HR, despite the reduction of radiation (PAR), combined to higher temperature inside the tunnel could be increasing the atmospheric vapour pressure deficit and therefore the evapotranspiration crop demand (Allen *et al*, 2006).

Economics

Net income and cost benefit ratio is significantly influenced by date of sowing and growing conditions. Net income and cost benefit ratio was maximum when sowing the crop on 30th December under tunnel. This might be due to high market value in off-season. Growers typically reported satisfaction with adopting this technology. The similar results were also reported by Sharon *et al*. 2010.

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