Peformance of knolkhol in chinese type polyhouse during peak winter in cold arid Ladakh

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ABSTRACT
An experiment was carried at Precision Farming Development Centre, Leh, SKUAST-K during the winter season of year 2016-17 to determine the growth and yield of knolkhol as influenced by different dates of transplanting and varieties under Chinese type polyhouse. The experiment was laid out in randomized block design with three transplanting date viz., 15th October, 25th October and 5th November and four varieties viz., King of market (V1), Purple Vienna (V2), White Vienna (V3) and G-40 (V4). The results revealed that maximum yield and its attributing traits was found best in 15th October planting. Among the varieties King of market and G-40 performed better as compared to other varieties during winter season in polyhouse condition.

Key words: Cold Arid, Knolkhol, Planting Date, Polyhouse, Varieties, Winter.

INTRODUCTION
Ladakh is known as cold arid region of India characterized by high altitude, low precipitation, high radiation, strong dry wind, extreme low temperature (-30°C) located in Trans Himalayas region of Jammu and Kashmir state. Due to extreme harsh agro climatic region the agriculture season is very short (3-4 months) ranging from May – September (Fig 1) which adversely affect the productivity. During winter the roads remained blocked for 5-6 months at two major connectivity due to heavy snowfall and one has to rely on outside for green vegetables transported via air which is costly and unaffordable by the small and marginal farmers. Despite the sub-zero temperatures, the cloudless skies in Ladakh guaranty over 300 sunny days per year which is the highest in the world. Therefore, there is plenty of sunshine for crops to grow even in winter under double wall polyhouse, provided that they can be prevented from freezing. To achieve these challenges, polyhouse come as a climate resilient technology which made it possible to grow green in Ladakh during peak winter period.

Knolkhol (Brassica oleracea cv. Gongylodes L.) is a temperate vegetable and not cultivated commercially. It is a rich source of vitamin A, C and minerals such as Ca, P, K, Mg and Fe (Anonymous 2016). It is one of the major crops of Kashmir valley and traditionally in Ladakh region it is grown as summer crops in open conditions whereas winter cultivation is not possible due to harsh climatic conditions. Therefore an attempt has been made to grow knolkhol under Chinese type polyhouse during winter season. However no literature is reported pertaining to this crop during winter season under polyhouse condition in cold arid.

MATERIALS AND METHODS
The Present investigation was conducted in Chinese type polyhouse of Precision Farming Development Centre, Leh which is situated at 3319m amsl latitude 33°58.551’ NS and longitude 77°41.995’ EW during the winter season of year 2016-17. Climate of the area is typically dry temperate with extreme fluctuation in the temperature (Fig 2) and soil is sandy loam. The dimension of Chinese polyhouse is 100×28 feet (Plate1) and is suitable for commercial cultivation in Ladakh region and best suits for the production of vegetables during winter months. The experiment was laid out in randomized block design with three different transplanting dates at 10 days interval viz., 15th October, 25th October and 5th November and four varieties viz., King of market (V1), purple Vienna (V2), white Vienna (V3) and G-40 (V4) were collected from different sources (Table1) Seeds were sown in mid September in double wall polyhouse condition. Observations were recorded on five randomly selected plants in each plot on eleven parameters viz., Plant height (cm), Leaf length (cm), Leaf width (cm), No. of leaves, Petiole length (m), Stalk length (cm), Gross knob weight (g), Net knob weight (g), Knob diameter (mm) and Yield/m2 (Kg).

The statistical analysis was done through OPISTAT software.

RESULTS AND DISCUSSION
The results revealed that vegetative growth of knolkhol was significantly influenced by the planting date. Significantly maximum gross knob weight, net knob weight, knob diameter and yield/m2 was recorded in 15th October dates of transplanting (357.63g, 324.57g, 60.00mm an 3.55kg/m2 respectively (Table 1). Whereas minimum gross knob weight, net knob weight, knob diameter and yield/m2

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Table 1: Effect of different dates of transplanting on yield of Knolkhol under polyhouse conditions during winter

| Treatments                  | Gross knob weight (g) | Net knob weight (g) | Knob diameter (mm) | Yield /m² (Kg) |
|-----------------------------|-----------------------|---------------------|--------------------|----------------|
| 15th October (D1)           | 357.638               | 324.575             | 60.008             | 3.556          |
| 25th October (D2)           | 319.850               | 272.850             | 57.289             | 2.901          |
| 5th November (D3)           | 290.550               | 261.350             | 53.960             | 2.873          |
| CD                          | 30.685                | 27.723              | 3.822              | 0.075          |
| CD SE(m)                    | 10.459                | 9.450               | 1.303              | 0.025          |
| Varieties                   |                       |                     |                    |                |
| King of market (V1)         | 389.733               | 342.700             | 59.150             | 3.718          |
| White Vienna (V2)           | 284.633               | 253.933             | 57.159             | 2.682          |
| Purple Vienna (V3)          | 289.417               | 256.400             | 50.902             | 2.812          |
| G-40 (V4)                   | 326.933               | 292.000             | 61.132             | 3.228          |
| CD                          | 35.432                | 32.012              | 4.413              | 0.086          |
| CD SE(m)                    | 12.077                | 10.912              | 1.504              | 0.029          |
| Interaction                 |                       |                     |                    |                |
| CD                          | 61.371                | 55.447              | 7.645              | 0.151          |
| CD SE(m)                    | 20.919                | 18.900              | 2.606              | 0.051          |

Plate 1: Performance of knolkhol in Chinese type polyhouse during peak winter

Length : 100ft
Width : 28ft
Outer side wall thickness : 4ft
Back wall thickness : 3ft
Central height : 8.25ft

Specific character: Double thickness with insulation in between and double door entry.

This result is in accordance with the findings of Dev (2012) in broccoli under lower hills of Himachal Pradesh.

With respect to yields traits variety King of market (V1) showed maximum gross knob weight (389.733g), net knob weight (342.700g) and yield/m² (3.718kg) respectively. Whereas minimum gross knob weight (g), net knob weight

was recorded in 5th November dates of transplanting (290.55g, 261.35g, 53.96mm an 2.87kg/m² respectively). This might be due to harsh environmental conditions as every delay in transplanting after 15th October resulted in constant decrease in yield and its attributes (Fig 2) as knolkhol require minimum temperature of 15°C for its successful cultivation.
Table 2: Effect of different dates of transplanting on growth of Knolkhol under polyhouse conditions during winter

| Treatments       | Plant height (cm) | Leaf length (cm) | Leaf width (cm) | No. of leaves | Petiole length (m) | Stalk length (cm) |
|------------------|-------------------|------------------|-----------------|--------------|--------------------|-------------------|
| Planting dates (D) |                   |                  |                 |              |                    |                   |
| 15th October (D1) | 56.33             | 26.219           | 18.225          | 12.125       | 19.900             | 2.750             |
| 25th October (D2) | 53.88             | 25.300           | 16.650          | 13.575       | 15.628             | 3.325             |
| 5th November (D3) | 48.18             | 21.488           | 15.175          | 13.063       | 17.300             | 3.005             |
| CD               | 2.395             | 0.956            | 0.721           | 0.558        | 1.300              | 0.346             |
| SE(m)            | 0.816             | 0.325            | 0.245           | 0.190        | 0.443              | 0.118             |

Varieties
- King of market (V1): 57.622 cm, 27.459 cm, 19.00 cm, 12.800 cm, 20.570 cm, 2.967 cm.
- White Vienna (V2): 52.511 cm, 22.667 cm, 14.333 cm, 13.667 cm, 18.467 cm, 3.633 cm.
- Purple Vienna (V3): 48.800 cm, 23.567 cm, 16.317 cm, 12.267 cm, 14.333 cm, 3.140 cm.
- G-40 (V4): 52.26 cm, 23.650 cm, 17.083 cm, 12.950 cm, 17.067 cm, 2.367 cm.
- CD: 2.765 cm, 1.104 cm, 0.832 cm, 0.645 cm, 1.501 cm, 0.400 cm.
- SE(m): 0.942 cm, 0.376 cm, 0.283 cm, 0.220 cm, 0.511 cm, 0.136 cm.

Interaction
- CD: 4.790 cm, N.S, N.S, 1.118 cm, 2.600 cm, N.S.
- SE(m): 1.632 cm, 0.6519 cm, 0.491 cm, 0.3810 cm, 0.886 cm, 0.2364 cm.

Table 3: Brief morphological description of Knolkhol varieties

| Varieties             | Morphological features                        | Source               |
|-----------------------|-----------------------------------------------|----------------------|
| King of market (V1)   | Round shape knob, petiole medium size          | Private seed company |
| White Vienna (V2)     | Light green, oval shape knob, tender, thin petiole and early. | SKUAST-K             |
| Purple Vienna (V3)    | Purple colour, round shape knob.               | SKUAST-K             |
| G-40 (V4)             | Early, large size leaf, dark green and round shape knob with thick petiole. | SKUAST-J             |

(g and yield/ m² (kg) were recorded in white Vienna (V2) of 284.63 g, 253.93g, 2.682/m². Similarly, G-40 (V4) showed maximum knob diameter of 61.00 mm followed by King of market (59.15), White Vienna (57.15) and lowest was found in Purple Vienna (50.90 mm). Similar findings were also obtained by Agrawal et al. (2003) in polyhouse conditions.

Effect of different varieties on vegetative growth was found significant for all traits under study. Maximum plant height was recorded in King of market (V1) 57.622 cm followed by G-40 with 52.26 cm whereas minimum plant height was found in Purple Vienna (48.80 cm). The increase in plant height, leaf length, leaf width and petiole length were observed in 15th October planting and for other traits viz., no of leaves and stalk length were obtained maximum in 25th October planting. (Table 3) This might be due to different genetical response and favorable environmental conditions prevailed during initial growth of crop. The results were in accordance to the finding of Chaudhari et al. (2015). Whereas the growth performance was minimum in 5th November planting when there is low temperature of -6.5°C in open condition and +0.5°C in polyhouse which was not a suitable temperature for its growth and development.

The interaction effect of planting time and varieties was found to be significant for maximum traits under study except for leaf length, leaf width and stalk length which were found non significant.

Abiotic stress due to extreme low temperature was observed during the month of January when the outside temperature was -17°C and in polyhouse -3°C which is completely not a favourable temperature for its successful growth and development. The plant remained stunted, curling of leaves and cracking of stem, knob and ice crystal formation are common symptoms observed during the month of January due to cold stress. To avoid the stress the polyhouse were covered with blanket during night hours to maintain the temperature for its survival.

On the basis of above results it may be concluded that transplanting of knolhkhol during 15th October was found best to get maximum yield under polyhouse in cold arid Ladakh to attain food and nutritional security.

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