

Evaluation of Heat Tolerant Cole Crop Varieties

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ABSTRACT

Cole crops, which include Cabbage, Cauliflower and Broccoli among others, occupy major components of vegetables in Bhutan. They are also important source of income, earning Nu. 106 million in 2016 from Cabbage and Cauliflower alone. However, production of these crops is largely limited to winter season to at most early spring given that they require cool season for growth and development. But the predicted climate change is likely to affect these crops since they prefer cool climates, and also there is increasing demand for these crops round the year. Therefore, to address some of these issues, heat tolerant Cabbage and Cauliflower varieties were introduced and evaluated in research fields of Agriculture Research and Development Centre, Wengkhari, Monggar. Crops were evaluated at Khangma (2100m), Lingmethang (650m) and Wengkhari (1650m) conditions during peak summer season when existing varieties cannot be cultivated. Results show that both the heat tolerant cabbage variety, Asha and Bengal King, can be produced during peak summer season even under Lingmethang condition. Of the two, Asha has greater potential for export market given its ideal size for Indian markets. The study also showed that heat tolerant cauliflower varieties, White Express 50 and Pragati 40, can be produced during peak summer season. Given their smaller size, they are also suitable for export markets in India. Of the two, Pragati 40 is more tolerant to heat and hence more suitable for cultivation in low lying areas. In general, these varieties provide not only options but also opportunities to deal with the emerging issues and needs.

Keywords: Heat tolerant; Cabbage; Cauliflower; Peak summer; Export market

1. Introduction

Cole crops are cultivated species of *Brassica oleracea* that includes Broccoli, Cabbage and Cauliflower among others. These crops are called Cole Crops since they originated from wild cliff cabbage also known as Cole Worts (Agroinfo 2017). They are cool season crops and are usually grown during winter season. They prefer about 7 to 13°C for optimal growth and development (AVRDC 1991). In Bhutan, among Cole crops, Cabbage and Cauliflower dominate in terms of production. For instance, in 2016, 6,685 ton of Cabbage and 2,082 ton of Cauliflower were produced, and sold worth Nu. 75 million and 31 million respectively (IMS 2016). Cabbage and Cauliflower varieties grown in the country today are conventional ones that prefer cool season that can be grown only during winter season, and they do not tolerate high temperature. Hence, as temperature rises due to anthropogenic climate change,

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these crops are likely to suffer negative consequences. In Bhutan, it has been observed that over the last two and half decades, temperature has risen by about 0.3 to 0.5°C (Tse-ring 2010; Phuntsho & Dorji 2014). Given this, it could even lead to change in cropping systems. High temperature affects plant growth and development and may cause substantial reduction in economic yield of crops (Wahid 2007). Till date, there are no published studies that tried to address this critical issue. Further, there is demand for year-round production of these Cole crops both within the domestic markets and huge potential to export during hot summer season to India, which is not possible with the existing varieties.

In order to deal with rise in temperature and demand for year-round consumption, especially during summer, there is a need to look for varieties beyond the existing ones. Evaluation of heat tolerant varieties could be one of the adaptation strategies. Heat tolerant crop is defined as those crop species that have remarkable heat tolerance adaptability under high temperature with a promising yield (Wahid 2007). Hence, this study evaluated production of heat tolerant varieties of Cabbage and Cauliflower during peak summer.

2. Materials and Methods

The trial was conducted at Agriculture Research and Development Centre, Wengkhar (1650 m.a.s.l.) and Agriculture Research and Development Sub-Centres Khangma (2100 m.a.s.l.) and Lingmethang (650 m.a.s.l.). Heat tolerant varieties of Cabbage, Bengal King and Asha and Cauliflower varieties, White Express-50 and Pragati-40 seeds were procured from Pahuja Private Seeds Limited and East West Seeds in India. Seeds were sown in staggered manner so as to try to produce crops during peak summer season when normal varieties are not suitable for production. Trial was set up using Randomized Block Design and management practices were followed as recommended (Tshering et al 2009). From each plot, 10 heads/curds were randomly selected and recorded their weight, length and diameter, and compactness of head in the case of Cabbage. Date of seed sowing, transplant and harvest were also noted. The data were analyzed using SPSS 22. One way ANOVA was used to compare the mean yield and crop duration for all varieties. For multiple mean comparisons, Duncan multiple range test was used.

3. Results and Discussion

Existing cabbage varieties are normally produced from mid July to mid March in areas above 1800 m sea level, mid June to February in areas ranging from 1400 to 1800 m and November end to early February for below 1400 m. For Cauliflower, existing varieties are produced from end of September to February for 1800 m and above, December to January for 1400 to 1800 m and for below 1400 m (Horticulture Sector 2015). The evaluation of new heat tolerant cabbage and cauliflower varieties provide promising result as they can be produced during the peak summer season even in low altitude areas like Lingmethang, which is located at around 650 m above mean sea level. However, one of the challenges of heat tolerant cole crops during peak summer season is enhanced pressure from pests and diseases.

3.1. Heat Tolerant Cabbage

Two types of heat tolerant cabbage varieties, Asha and Bengal King can be successfully produced during hot summer season under Lingmethang condition in just more than two months' period (Table 1). Bengal King had significantly larger head weight than Asha (P -value <0.001). However, Asha is ideal for export market (India) in terms of head size, compactness and colour since head with less than one kilogram is preferred in Indian markets.

Table 1. Cabbage evaluation at Lingmethang

Variety	Transplant to harvest (days)	Head weight (gm)	Harvest time
Asha	66	915±139 ^a	June
Bengal King	68	1309±391 ^b	June

3.2. Heat Tolerant Cauliflower

Heat tolerant Cauliflower varieties, White Express 50 and Pragati 40 can also be produced during summer season under Lingmethang condition though by nature these are small size compared to existing cauliflower varieties in Bhutan. These varieties can also be produced in much shorter duration than normal ones (Table 2). White Express 50 had significantly larger curd size than Pragati 40 (P value = 0.026). These are ideal size for export to Indian markets since they prefer curd with weight less than a kilogram (Phuntsho et al 2017)

Table 2. Cauliflower evaluation at Lingmethang

Variety	Transplant to harvest (days)	Curd weight (gms)	Harvest time
White Express 50	41	331±122 ^a	June
Pragati 40	41	257±73 ^b	June

3.3. Staggered Production Trial of Cauliflower

Among the Cole Crops, Cauliflower is most sensitive to temperature. Temperature either sides of its ideal range would lead to crop failure, and hence, cropping season is critical. To ascertain its ideal growing time, staggered production trial of the two varieties was conducted at Wengkhari condition during the summer season (Table 3 and 4). For White Express 50, of the three growing periods, June harvest produced significantly higher curd yield (P value <0.001) as shown in Table 3.

Table 3. Staggered evaluation of Cauliflower White Express 50

Harvest time	Transplant to harvest (days)	Curd weight (gms)
May	39	183±59 ^a
June	63	433±126 ^b
October	59	185±56 ^a

Pragati 40 was tried in two growing periods. Among the two, June harvest gave significantly higher curd yield than October harvest (P value < 0.001). In fact, the result (Table 4) clearly showed that Pragati 40 is not suitable for production in October month and beyond, which indicates that it is more sensitive to cold (or rather more heat tolerant) than White Express 50.

Table 4. Staggered evaluation of Cauliflower Prgati 40

Harvest time	Transplant to harvest (days)	Curd weight (gms)
June	47	253±197 ^a
October	59	58.0±25 ^b

Heat tolerant varieties of Cauliflower were also tried under Khagma condition (2100 m) but bolted because of low temperature which is an indication of heat tolerant varieties. Further, as a control, normal Cauliflower variety, Wengkhar Metokopi I, was also tried for May, June and October production along with the two heat tolerant varieties. However, it failed to form curds during May and June and produced only during November. But the average weight of the curd was just 194 gm, which is significantly lower than its normal weight (600 gm) indicating that normal existing varieties cannot be produced during the summer season.

4. Conclusion

Cole crops are among the major vegetable crops that generate significant income for growers. These crops prefer cool season and hence are produced only during winter season to early spring. Expected rise in temperature due to climate change are likely to affect these crops, and also there is increasing demand for these crops during summer season. Hence, these heat tolerant varieties are expected to provide some solutions towards addressing the aforementioned issues.

Acknowledgement

We would like to thank the management and Elementary Support Personnel (ESP) of Agriculture Research and Development Centre, Wengkhar, Monggar for their unwavering support to conduct research trials. Thanks also due to Regional Agriculture Marketing and Cooperative Office, Monggar, for helping to source the seeds of heat tolerant crops varieties.

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