

Performance Evaluation of Cabbage (*Brassica oleracea Capitata*) Cultivars in Mid-hills of Nepal for Winter Season Production

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Abstract— Cabbage (*Brassica Oleracea Capitata*) is being one of the most popular and demanded vegetables and in Nepal. Five cultivars; Wonder ball, Green voyager, Green challenger, Omphalus and Green coronet were transplanted in first week of October in 2016 and 2017 consequently years in mid-hills (Kathmandu valley, 1300 masl) and grown during winter season with 45X45 cm spacing. Crops were fertilized with 200:120:100 N.P.K Kg/ha and 15 ton FYM/ha. One spray insecticide and fungicide were sprayed in the early season for crop establishment. The main objective of this experiment was to find out suitable high yielding and insect pest and disease field tolerant hybrid cabbage cultivars for commercial growing in mid-hills of Nepal. Crops were evaluated with its vegetative, insect pest and disease, yield and farmers and consumers response in two consecutive years. Result showed that among the tested cultivars Wonder ball was found highly uniform, vigorous, less attack by insect pest and disease, significantly higher yield (71.7 t/ha), higher average head weight (1622 g), early harvestable (95 days), freshness (4.0) and market preference (4.0) as compared to check Green coronet widely grown cultivar Green coronet which has only yield (57.91 t/ha), average head weight (1358 g), days to harvest (114 days), freshness (3.0) and market preference (3.0) respectively. It was followed by Green challenger which had yield (57.77), average head weight (1387), earlier harvestable (95 days), freshness (4.0) and market preference (4.0). Hence, Wonder ball and Green challenger have been selected and recommended for varietal registration and commercial cultivation in mid-hills of Nepal.

Keywords— cabbage, hybrid cultivars, insect pest and disease, mid-hills, yield.

I. INTRODUCTION

Cabbage (*Brassica oleraceae* var. *capitata*) is one of the most important leafy vegetables worldwide (Talekar, 2000[10]). Cabbage originated from a wild non heading

type, 'cole wart' (*Brassica Oleracea* var. *sylvestris*) and considered the real headed cabbage evolved in Germany. At present cabbage is grown in Caribbean countries, Indonesia, Malaysia, Central East and West America (Tamil Nadu Agricultural University, 2011[9]). Cabbage belongs to the family of Brassicaceae and genus of Brassica. Cabbage (*Brassica Oleracea Capitata*) is one of the most popular vegetables in the world because of its adaptability to a wide range of climatic conditions and soil types, ease of production and storage, and its food value. Cabbage is believed to have evolved from a wild form native to Europe, growing along the coast of the North Sea, the English Channel and northern Mediterranean. The cabbage has been ranked by the Food and Agriculture Organization among the top twenty vegetable crops grown, establishing it as an important food source, globally (FAO, 1988[5]). The cabbage is a cool season crop which grows best under cool, moist weather conditions (Thompson, 2002[11]). The cabbage is a crop plant that is easily grown on a wide range of soil types and is adaptable to many different climatic conditions (Smith, 1995[8]). Cabbage is one of the most important cole crops of Nepal. It covers 28071 ha, 468836 mt production and 16.7 mt/ha productivity in Nepal (VDD, 2016[12]). It can be cultivated throughout the year if proper varieties are selected and planted. It favors in cold climate and soil pH with 5.5 to 6.5. According to climatic requirement, it can be categorized into 3 groups; early, medium and late maturing type. Nowadays hybrid cabbage cultivation is increasing. It is grown throughout the country from terai (plain area) to high hills but planting time might be different. Cabbage yield and yield characteristics are determined by several factors, such as variety, plant spacing, environmental conditions and market requirements, among others. Days to maturity, or earliness, in cabbage is largely determined by variety, and is a desirable characteristic when varieties with short growth cycles are required to meet market demands (Cervenski, *et al.*, 2012[4]).

Cabbage grows best in cool moist climate and is very hardy to frost. Well hardened seedlings can tolerate temperature of 20⁰ F to 25⁰ F. It is grown as rabi crop during winter (AgriInfo.in, 2015[2]). Commercial cultivation of cabbage is very successful due to high market demand. In the recent years, hybrid cabbage cultivation is increasing. Due to the availability of heat-tolerant cultivars, Cabbage may also be grown in summers as an off-season vegetable.

Cabbage is a good source of vitamin C and sulphur. Cabbage helps with constipation. Cabbage helps with gastric ulcers. Cabbage helps in reducing cholesterol. Cabbage has anti-inflammatory properties; cabbage has anti-ageing properties and helps in repairing damaged skin cells.

The main objective of this experiment was to find out suitable high yielding and insect pest and disease field tolerant hybrid cabbage cultivars for commercial growing in mid-hills of Nepal.

II. MATERIALS AND METHODS

Five hybrid cultivars of cabbage were evaluated at HRD farm Khumaltar where four hybrid cultivars for testing were collected from Monsanto Holding Pvt. Ltd. India through Nepal Agrocenter Janakpur and one cultivar (Green Coronet) was collected from the market which is widely grown in Nepal was kept as check variety. Three weeks old seedlings were transplanted in first week of October in 2016 and 2017 consequently years in mid-hills (Kathmandu valley, 1300 masl) and grown during winter season with 45X45 cm spacing. One spray insecticide and fungicide were sprayed in the early season for crop establishment.

The standard recommended dose of fertilizers (200:120:80 NPK kg/ha + 15 ton FYM/ha) was applied and application of pesticide and fungicide was minimized. Plants were top dressed with urea after 25 days of transplanting. Irrigation was done as needed with pipe irrigation. Vegetative, insect pest and disease, and yield parameter data were recorded during the season.

III. RESULTS AND DISCUSSION

Vegetative parameter

No any significant difference observed in both the years among the varieties tested in both the years. However, Wonder ball showed more plant uniformity in both the years followed by Green voyager. Cumulative mean of the two years was 4.8 in Wonder ball and 4.7 in Green voyager. Omphalus had least plant uniformity (4.2) in 2016 and Green challenger had least (4.1) in 2017 (Table 1). Similarly, cumulative mean of plant vigor was highest in Wonder ball (4.4) and Omphalus (4.4) but not significantly different. In 2016, all the varieties showed vigorous growth in early stage as compared to 2017 but it does not correlate with head formation.

Effect of varieties on plant height upto head was significant in both the years. Cv. Wonder ball had tallest plant height up to head in 2016 (23 cm) and 2017 (33.9 cm) with mean 28 cm followed by Green challenger which had plant height up to head in 2016 (23 cm) and 2017 (33.3 cm) with mean 28.1 cm. Omphalus had the least plant height (17 cm) up to head in 2016 and Green coronet (30.5 cm) in 2017 respectively (Table 1). It showed that early maturing varieties had shorter plant height up to head.

Table.1: Vegetative characteristics of hybrid cabbage varieties at Khumaltar (2016 & 2017)

| Cultivars | Plant uniformity | | | Plant vigor | | | Plant height upto head (cm) | | |
|--------------------|------------------|-------|--------|-------------|-------|--------|-----------------------------|------|--------|
| | 2016 | 2017 | C Mean | 2016 | 2017 | C Mean | 2016 | 2017 | C Mean |
| Wonder ball | 4.7 | 5.0 | 4.8 | 4.5 | 4.4 | 4.4 | 23 | 33.9 | 28 |
| Green voyager | 4.7 | 4.8 | 4.7 | 4.7 | 3.6 | 4.1 | 21 | 31.6 | 26.3 |
| Green challenger | 4.7 | 4.1 | 4.4 | 4.5 | 3.6 | 4.0 | 23 | 33.3 | 28.1 |
| Omphalus | 4.2 | 4.4 | 4.3 | 4.7 | 4.2 | 4.4 | 17 | 32.8 | 24.9 |
| Green coronet (ch) | 4.5 | 4.2 | 4.3 | 4.7 | 3.6 | 4.1 | 18 | 30.5 | 24.2 |
| GM | 4.5 | 4.5 | 4.5 | 4.6 | 3.8 | 4.2 | 20.4 | 32.4 | 26.4 |
| CV% | 12.5 | 16.49 | 5.9 | 10.57 | 15.46 | 7.21 | 6.28 | 4.9 | 6.10 |
| F-test | ns | ns | ns | ns | ns | ns | ** | * | * |
| LSD (0.05) | | | | | | | - | 3.00 | |

Plant spreading size at the time of harvest was significantly different among the tested varieties in 2017. Plant size was also bigger in 2017 as compared to 2016 that

reflected on head yield also. The major reason behind this was due to timely rain fall occurred in 2017. Plant spreading size was highest with Omphalus (38x33 cm) followed by

Green coronet (36x31 cm) and least spreading size was with Green challenger (28x30 cm) in 2016. Hence, late maturing

varieties are bigger in plant spreading size (Table 2) but do not reflect on yield.

Table.2: Combined mean of plant spreading size (length and width) of hybrid varieties of Cabbage at Khumaltar (2016 & 2017)

| Cultivars | Plant length (cm) | | | Plant width (cm) | | |
|--------------------|-------------------|------|--------|------------------|------|--------|
| | 2016 | 2017 | C Mean | 2016 | 2017 | C Mean |
| Wonder ball | 30 | 46 | 38 | 32 | 47.5 | 39.7 |
| Green voyager | 32 | 38 | 35 | 30 | 36.1 | 33.0 |
| Green challenger | 28 | 39.8 | 33.9 | 30 | 37.5 | 33.7 |
| Omphalus | 38 | 42.3 | 40.1 | 33 | 43.0 | 38 |
| Green coronet (ch) | 36 | 39.5 | 37.7 | 31 | 37.4 | 34.2 |
| GM | 32.8 | 41.1 | 36.9 | 31.2 | 40.3 | 35.7 |
| CV% | 14.79 | 6.55 | 10.50 | 7.8 | 6.87 | 7.7 |
| F-test | ns | * | ns | ns | ** | 7.7 |
| LSD (0.05) | - | 5.07 | | - | 5.24 | |



Fig 1. Wonder ball

Green voyager

Green coronet



Fig 2. Internal structure: Wonder ball

Green voyager

Green coronet

Insect and Disease Parameter

Insect damage was significantly low in Green voyager (2.3) among the tested cultivars in 2017 and also have low cumulative mean (2.7). This experiment showed that, early maturing varieties ; Wonder ball, Green voyager and Green challenger have less insect damage may be due to less period expose in the field for insect damage. Insect damage was due to the occurrence of aphid, cabbage butterfly and diamond back moth. Downy mildew was noticed in 2016

only but no any significant difference noticed. However, Omphalus was free from downy mildew. Alternaria leaf spot disease was noticed in both the years and Wonder ball had significantly lower leaf spot (1.7) among the varieties in 2016. Cumulative mean showed that early maturing varieties are less attacked by leaf spot disease, may be due to fewer periods exposed in the field and become escaped from the multiplication of disease (Table 3).

Table.3: Insect and disease parameter of hybrid varieties of Cabbage at Khumaltar (2016 & 2017)

| Cultivars | Insect damage (1-9) | | | Alternaria leaf spot (1-9) | | | Downy mildew (1-9) |
|--------------------|---------------------|-------|--------|----------------------------|-------|--------|--------------------|
| | 2016 | 2017 | C Mean | 2016 | 2017 | C Mean | 2016 |
| Wonder ball | 3.5 | 4.3 | 3.9 | 1.7 | 4.3 | 3.0 | 1.2 |
| Green voyager | 3.2 | 2.3 | 2.7 | 3.2 | 4.6 | 3.9 | 1.2 |
| Green challenger | 3.0 | 4.0 | 3.5 | 3.0 | 3.6 | 3.3 | 1.5 |
| Omphalus | 4.0 | 5.0 | 4.5 | 3.5 | 5.0 | 4.2 | 1.0 |
| Green coronet (ch) | 3.7 | 5.0 | 4.3 | 3.7 | 5.0 | 4.3 | 1.2 |
| GM | 3.4 | 4.1 | 3.7 | 3.1 | 4.5 | 3.7 | 1.2 |
| CV% | 14.52 | 25.37 | 16.36 | 25.19 | 26.53 | 13.52 | 35.02 |
| F-test | ns | * | ns | * | ns | ns | ns |

Yield attributing Parameter

The days to head formation was significantly earlier in Green voyager (54 DAT) and Green challenger (55 DAT) in both the years. Omphalus and Green coronet produce late head formation (61 DAT) (Table 4). Beside this, Wonder ball, Green voyager and Green challenger had significantly earlier days to harvest as compared to check Green coronet and Omphalus. Adeniji et al., 2010[1] also suggested that for farmers growing cabbage in both tropical and temperate climates, varieties with a short growing season, or less number of days to maturity, are more advantageous for meeting early market demands. Monuruzzaman 2011[7], had also reported that in his ten hybrid cabbage varieties

evaluation during winter in Rangamati hill, Bangladesh found longest duration (119 days) to harvest Green coronet cultivar. Likewise, varietal effect on average head weight was significant where cumulative mean was significantly higher in Wonder ball (1622 g) followed by Omphalus (1533 g) where as the least head weight was obtained in Green voyager (1318 g). Head weight of all the cultivars was higher in 2017, one of the reason is timely rainfall in 2017. In 2016, Green coronet had least head weight (1043 g) and Wonder ball had the highest head weight (1232 g). In 2017 also, Wonder ball had significantly higher head weight (2012 g). Hence, even though Wonder ball is early maturing cultivar, higher yield in both the years.

Table 4: Yield Parameter of Hybrid Cabbage Varieties at Khumaltar (2016 & 2017)

| Cultivars | Days to head formation | | | Average head wt. (gm) | | |
|--------------------|------------------------|-------|--------|-----------------------|--------|--------|
| | 2016 | 2017 | C Mean | 2016 | 2017 | C Mean |
| Wonder ball | 54 | 58 | 56 | 1232 | 2012 | 1622 a |
| Green voyager | 55 | 53 | 54 | 1115 | 1521 | 1318 b |
| Green challenger | 54 | 56 | 55 | 1164 | 1610 | 1387 b |
| Omphalus | 60 | 61 | 60.5 | 1160 | 1907 | 1533 a |
| Green coronet (ch) | 58 | 64 | 61 | 1043 | 1674 | 1358 b |
| GM | 56.2 | 58.4 | 57.3 | 1142.8 | 1744.8 | 1443.7 |
| CV% | 5.23 | 11.26 | 3.74 | 10.59 | 7.94 | 8.35 |
| F-test | * | * | * | ns | ** | ns |
| LSD (0.05) | - | 8.47 | 5.95 | - | 261 | 105.5 |

Wonder ball gave highest yield in both the years and cumulative mean (71.7 t/ha) was significantly higher as compared to the rest of the cultivars. It was followed by Omphalus (59.49 t/ha) and Green Coronet (57.91 t/ha) respectively. The yield of Wonder ball (45.98 t/ha) was followed by Green challenger (71.38 t/ha) and Green voyager (41.37 t/ha) in 2016. Likewise, the yield of Wonder ball (97.42 t/ha) was significantly higher followed by Omphalus (78.78 t/ha) and Green Coronet (78.40 t/ha)

respectively in 2017 (Table 5). It also supports the findings of Albert (2009) who has mentioned the yield of cabbage depends upon the variety, growing season and management practices. He obtained hybrid cabbage yield upto 50 tons/ha. The yield of late season varieties is about 20 to 25 tons/ha. But in this experiment, hybrid cultivars yield is higher than he obtained, it may be due to favorable weather in 2017, better management practices and may be due to potential modern high yielding varieties.

Table.5: Yield Parameter of hybrid Cabbage varieties at Khumaltar in 2016 & 2017

| Cultivars | Total yield (t/ha) | | | Days to harvest |
|--------------------|--------------------|-------|--------|-----------------|
| | 2016 | 2017 | C Mean | 2017 |
| Wonder ball | 45.98 | 97.42 | 71.7 | 94.7 |
| Green voyager | 41.37 | 74.17 | 57.77 | 90.3 |
| Green challenger | 41.45 | 71.38 | 56.41 | 94.7 |
| Omphalus | 40.21 | 78.78 | 59.49 | 105.7 |
| Green coronet (ch) | 37.42 | 78.40 | 57.91 | 113.7 |
| GM | 41.28 | 80.03 | 60.65 | 99.8 |
| CV% | 8.84 | 11.73 | 9.74 | 4.51 |
| F-test | ns | * | * | ** |
| LSD (0.05) | | 17.68 | 16.40 | 8.47 |

Farmers and Consumers Preferences

Response from the invited farmers and consumers showed that Wonder ball was highly selected due to its very good; size, shape, color, freshness, plant appearance, market value and yield. On the basis of size, shape, freshness, market value, yield, insect damage and disease infection, the early maturing varieties; Wonder ball, Green voyager and Green challenger was more preferred than late maturing varieties; Omphalus and Green coronet. The late maturing varieties; Omphalus and Green coronet had preference only for plant appearance (Table 6).

Table.6: Farmers and consumers response of hybrid Cabbage varieties at Khumaltar in 2017

| Cultivars | Farmers response (1-5) | | | | | | | | |
|--------------------|------------------------|-------|-------|-----------|------------------|--------------|-------|--------|---------|
| | Size | Shape | Color | Freshness | Plant appearance | Market value | Yield | Insect | Disease |
| Wonder ball | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 2.0 | 2.0 |
| Green voyager | 4.3 | 4.0 | 3.6 | 4.0 | 4.0 | 4.3 | 4.6 | 2.3 | 2.3 |
| Green challenger | 4.4 | 4.0 | 3.8 | 4.0 | 4.0 | 4.0 | 4.0 | 1.6 | 2.3 |
| Omphalus | 3.3 | 3.5 | 4.0 | 3.3 | 4.3 | 3.0 | 3.0 | 3.0 | 2.6 |
| Green coronet (ch) | 3.0 | 3.0 | 3.3 | 3.0 | 4.3 | 3.0 | 3.3 | 3.3 | 2.3 |
| GM | 3.8 | 3.7 | 3.7 | 3.6 | 4.1 | 3.6 | 3.7 | 2.4 | 2.3 |
| CV% | 10.73 | 6.04 | 11.37 | 7.04 | 9.37 | 7.04 | 8.99 | 28.18 | 29.28 |
| F-test | * | *** | ns | ** | ns | *** | ns | ns | Ns |
| LSD (0.05) | 0.72 | 0.42 | | 0.48 | | 0.48 | 0.64 | | |

Farmers response; 1: unacceptable, 5: Excellent

IV. CONCLUSION AND RECOMMENDATION

On the basis of overall characters, cv. Wonder ball which was uniform, vigorous, less attack by insect pest and disease, significantly higher yield (71.7 t/ha), higher average head weight (1622 g), early harvestable (95 days), freshness (4.0) and market preference (4.0) as compared to check Green coronet widely grown cultivar has been selected and recommended for registration and , whereas Green coronet has only yield (57.91 t/ha), average head weight (1358 g), days to harvest (114 days), freshness (3.0) and market preference (3.0) respectively. It was followed by Green challenger which had yield (57.77), average head

weight (1387), earlier harvestable (95 days), freshness (4.0) and market preference (4.0). Hence, Wonder ball and Green challenger have been selected and recommended for varietal registration and commercial cultivation in mid-hills of Nepal.

Short description of Wonder Ball

1. Cross (Parents) : WFM117-1511CMS X WTR134-008
2. Country of Origin : Netherland
3. Agronomic Character ;
 - i. Plant uniformity : 4.8 scale rate out of 5
 - ii. Average head weight : 1622 gram

- iii. Average Yield ton per hectore : 71.7
- iv. Days to mature from transplanting : 94 days
- v. Days to head initiation : 56 days
- vi. Average head length : 38 cm
- vii. Head Width : 39.7 cm
- viii. Leaf spot : 3.0 out of 9 scale
- ix. Downy mildew : 1.2 scale rate out of 9 in 2016

Morphological data;

- Plant type : Semi-erect
 - Growing Climate: Winter season
 - Leaf color : Dark green
 - Leaf shape : Orbicular
 - Seed Color : Dark brown
 - Head Color : Attractive Green
 - Head shape : Round
 - Internal structure : Excellent
4. Distinctness: It is round shape head with attractive green color. It has good taste and high yield efficacy. It is preferred and early maturing variety.

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