

## Comparison of Four Cultivars of Broccoli (*Brassica oleracea* var. *Italica Plenck*) in Sulaimani Governorate

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### Abstract

The experiment was carried out to compare different cultivars of broccoli during winter growing season 2006 - 2007 at Awbara field, . This experiment was performed as Randomized Complete Block Design using four cultivars representing (4) Broccoli cultivars vic: "Autumn spear calabrese", "Hydra-F1 calabrese", "Late purple sprouting", and "Corvet-F1 calabrese" with four replications. Means comparisons were carried out by Revised LSD at a significance level of (1%) for chemical analysis and (5%) for the field parameters. The results showed that maximum plant height, plant dry weight, number of lateral branches ,weight of lateral heads, total plant yield and total yield.ha<sup>-1</sup> were obtained from "Late purple sprouting", while maximum leaf number, leaf weight, leaf area, head dry weight, head width and seed weight were obtained from " Corvet-F1 calabrese". However the highest plant dry matter percentage , chlorophyll a and shortest time to harvest was gained from "Hydra-F1 calabrese", maximum head fresh weight and chlorophyll b were obtained from "Autumn spear calabres.

**Key words:** Broccoli, Cultivars, Comparison

### Introduction

Broccoli (*Brassica oleracea* var. *Italica*) belongs to Brassicaceae (Cruciferae) family.

Sadik (1962) observed that the distinction between broccoli and cauliflower is made by their comparative morphology at the harvest stage. Niewhof (1969) observed that the green sprouting form yield produced from multiple harvests of lateral heads or sprouts, whereas the heading form produced from a large, single, terminal inflorescence. Seeling (1971) indicated that before the present of popular heading forms, the term broccoli was used to describe the green sprouting form. Gray (1982) reported that marketable broccoli is ontogenetically more than marketable cauliflower. Most broccoli are green in color due to chlorophyll within the sepals of the floral buds, this contrasts with the white or cream color curd in cauliflower which lacks chlorophyll. Dhawan *et al.*(1983) demonstrated that the cultivar "Marathon lamina" is more sensitive to subzero temperature(-5°C) than "Fiesta" cv. at the floral

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initiation stage. Broccoli is a cool season crop that may be grown early in the spring or late in the fall (Hamson, 1992). Stephens (1994) indicated that broccoli has two different distinct forms, the first one is "sprouting broccoli" which makes somewhat branching cluster of green flower buds, a thick top, a green flower stalk, and smaller clusters that arise like "sprouts" from the stem. Damato and Trotta (2000) carried out an experiment to study the effect of three broccoli cultivars on growth and yield. Their results showed that "XPH 442" and "Grant vert" were the most and least productive (11.6 and 8.0 t. ha<sup>-1</sup>), respectively. "Grant vert" showed smaller bud size and no hollow stem, where as the lowest percentage of bractiness was noticed from "XPH4142". The term (Cole crops) refers to a waxy leaved brassicas of European origin, of the species *Brassica oleraceae*. Wikipedia (2005) reported that the common varieties of broccoli are calabrese and purple sprouting broccoli. Drost and Jahson (2005) noticed that there are many good broccoli cultivars with early maturity, e.g. Packman (50 days) and Green comet (55 days).

In view of these, an investigation was conducted to study the growth and yield characters of some broccoli plant cultivars under Sulaimani conditions.

### **Materials And Methods**

This experiment was carried out from September 2006 to June 2007 at Awbara field, Department of Horticulture, College of Agriculture, University of Sulaimani, Kurdistan region, Iraq, located on 2 Km south western of Sulaimani city, with 35<sup>o</sup> 34' N, 45<sup>o</sup> 22' E and 741 meters above mean sea level.

The media which was used for sowing the seeds was prepared previously, containing a mixture of sand, peat moss and ordinary fine field soil (1:1:1) respectively. Boxes of 30 x 60 x 20 cm were filled with media for seed sowings.

Seeds of the experiment were sown on September 15<sup>th</sup> 2006, the field was prepared through cultivating by rotary rotivator and the rows were prepared mechanically. The seedlings were planted, after they reached 3-4 leaves, in one side of the rows at 40 cm distance between the plants with eight plants in each row. Fertilizers of 200 kg.ha<sup>-1</sup> N, 25 Kg. ha<sup>-1</sup> P of urea and super phosphate, (Matlob *et al*,1980) were applied band placed plus animal manure added at the time of soil preparation at the rate of 40 m<sup>3</sup>. ha<sup>-1</sup> .

The experiment consisted of four broccoli cultivars. It was of Randomized Complete Block Design included (4) treatments representing

“Autumn spear calabrese”, “Hydra-F1 calabrese”, “Late purple sprouting” and “Corvet-F1 calabrese” produced by Jamie Oliver and Wilko company. The field was divided into 4 blocks; each block consisted of 12 rows which represents 4 plots. The results were analyzed statistically and means separated with revised least significant differences (R.L.S.D) test at a significant level of 1% for chemical characteristics and 5% for other characteristics after they showed their significance as described by Othman *et al.* (2003). Values were subjected to logarithmic and square root transformations whenever it was necessary.

After (160-180) days from sowing, central and lateral heads having closed floral bud, dark green or purple color and good compactness with a length of 12-15 cm of the stem were harvested. Growth parameters i.e. plant height (cm), leaf number, leaf fresh weight (g), leaf area (cm<sup>2</sup>), Plant dry weight (g), plant dry weight%, lateral branches dry weight (g), stem's dry weight(g) and No. of branches/ plant (for three random plant in each plot) were recorded.

Other data were recorded from harvested plant: head diameter (cm), head fresh and dry weight. plant<sup>-1</sup>(g), head dry matter %, head diameter (cm), no. and weight of lateral heads. plant<sup>-1</sup> (g), total yield. plant<sup>-1</sup> (g), productivity (t. ha<sup>-1</sup>), seed yield (g. plant<sup>-1</sup>) (three plants were labeled from each plot) and time to harvest (days from sowing). In head of broccoli cultivars, ascorbic acid was measured by classical titration method using 2,6-dichlorophenol indophenols solution in (mg.100g<sup>-1</sup>) sample according to (A.O.A.C.,1995). Chlorophyll a and b contents were determined in fresh leaves as (mg. g<sup>-1</sup> fresh weight) according to (Knudsen method as described in Winternans and DeMots, 1965).

### **Results and Discussion**

Table (1) shows the effect of the cultivars on the plant height, in which significant differences occurred. Maximum value with respect to plant height (55.5cm) was obtained from "Late purple sprouting", while the lowest plant height (21.9 cm) was obtained from "Hydra-F1 calabrese" . Zerkoune (2000) displayed that there were significant differences among 12 broccoli cultivars. These results may be due to differences between the cultivars in adaptation to environments and their responses to suitable environmental effects and their ontogenetic.

The same table shows significant difference among four cultivars grown in Awbara regarding leaf number. Maximum number (36.8) was attained from "Corvet-F1Calabrese cv.", while the minimum number (21.9) obtained from "Hydra-F1Calabrese". Other workers such as Nowbuth (1997) have also reported such effects of cultivar on cauliflower. The reasons may be due to plant height , number of nodes on the plant and



Autumn spear calabrese	33.9	30.0	389.9	5630	63.12	7.85	7.60
Hydra-F1 calabrese	21.9	21.9	133.3	1925	66.71	11.06	5.95
Late purple sprouting	55.5	22.5	355.3	5317	70.35	9.04	8.15
Covet-F1 calabrese	37.5	36.8	470.2	6347	48.58	5.59	6.50
Significance R.LSD	5.78*	10.42*	120.3**	2073**	13.07*	0.90**	1.99*

Table (2) shows that head fresh weight was significantly affected by cultivars. The highest mean (276.1g) was obtained from "Autumn spear calabrese cv." , while the lowest mean of head fresh weight (122.9) was obtained from "Hydra-F1calabrese cv." and the highest mean of total plant yield (455.9g) and productivity(12.66 t.ha-1)was obtained by Late purple sprouting. . Lawson (2000) reported some differences in head weight among 12 cultivars, head weights ranged between 1.30 Ibs (585 g) and 0.70 lbs (315 g). Head fresh weight for export market was described as having a mean of 275- 350g (Titely, 1981). Differences between cultivars may be due to other growth characteristics such as leaf number and leaf areas which were associated with higher broccoli head weights (Guan et al., 1995).

The same table shows that head dry weight was significantly affected by cultivars. Maximum value was (24.99g) obtained from "Corvet-F1calabrese cv." , while the lowest value was (10.13g) obtained from "Hydra-F1calabrese cv.". These results may be referred to differences in head fresh weight and dry matter percent due to accumulation of mineral components. Generally, Brassica dry matter yield depend on the production potential of soil and environment and the brassica species (Alt et al., 2001).

Table (2) shows no significant differences between cultivar's head dry matter percent.

Table (2) shows the effect of cultivars on head width. The highest mean was (13.64 cm) were obtained from"Corvet-F1calabrese", while the lowest means of head diameter (9.46) were obtained from "Hydra-F1calabrese cv.". These differences among the cultivars are in accordance with those obtained by Zerkoune (2000) that displayed significant differences between twelve cultivar tested. "Marathon cv." had larger head diameter compared , while "Fiesta cv." had the smallest head diameter. These differences showed that there were genotypic potential for gaining the head type.

Table (2) shows that weight of lateral heads were significantly affected by cultivars. The maximum value was (234.56 g) obtained from "Late purple sprouting cv." and the minimum value (101.54 g) was obtained from "Hydra-F1Calabrese". These results may be referred to differences in number of lateral heads. plant<sup>-1</sup> in which "Late purple sprouting" have the largest number and this may be due to genotype factors.

The same table shows that total plant yield were significantly affected by cultivars. The maximum value was (455.9g ) obtained from "Late purple sprouting cv." , while the minimum value (224.5 g ) was from "Hydra-F1Calabrese cv.", and this may be related to the previous results obtained in this study regarding head and lateral weight. The effect of cultivar reported in this investigation is in agreement with those obtained by earlier workers.

Table (2) shows that total yield per hectare was significantly affected by cultivars. The maximum yield (12.664 t. ha<sup>-1</sup>) obtained from "Late purple sprouting cv. " These results a greed with the results of Damato and Trotta (2000) with other cultivars who showed that "XPH 442" and "Grant vert cv." have productive yield of( 11.6) and (8.0 t. ha<sup>-1</sup>) , respectively . Damato (2000) recorded that broccoli cultivars "Toto" and "Compact " were more productive of central heads (10 t .ha<sup>-1</sup>) than the yield obtained from "Grande cv. (5.0 t .ha<sup>-1</sup>). This may be due to genotype effects that present different characters in fresh weight of broccoli head per unit area (t. ha<sup>-1</sup>) or mean head fresh weight (g. head<sup>-1</sup>) and/or the effect of environmental and agronomic conditions on quality attributes of broccoli.

Table (2) shows that seed weight was significantly affected by cultivars. The maximum weight (41.12 g) was obtained from "Corvet-F1 calabrese cv. " and the minimum value (26.10 g ) was obtained from "Autumn-spear calabrese". These results in accordance with Al-Obadi (1999) in respect to two cauliflower cultivars, that the seed yield plant<sup>-1</sup> in "Winner cv." was more than "Brio cv. " . Genotypic and phenotypic correlations were of high order in respect of primary an secondary branches and number of pods on the main shoot with seed yield (Yadav and Singh, 1996).

Table (2) shows that this parameter was also significantly affected by cultivars. The largest period was (196.1) days taken by "Late purple sprouting cv.", while "Hydra-F1Calabrese cv." (162.1 days) took the shortest period to maturity. These differences in maturity duration may be genotypic in nature. Although (Chung 1982; 1985 and Chung and Strickland 1986) reported the possibility of harvesting at the same time for processing broccoli, most cultivars do not mature uniformly and most be harvested selectively in a series of harvest For fresh market broccoli,

harvesting in the same time is uncommon and not practical because it results in wide variation in size and quality.

Table (3) shows that Chlorophyll a and b significantly affected by cultivars. The maximum values (0.91 mg.g<sup>-1</sup>) and (0.36 mg.g<sup>-1</sup>), respectively were obtained from "Hydra-F1 Calabrese cv.", while the minimum value (0.71 mg.g<sup>-1</sup>) and (0.359 mg.g<sup>-1</sup>), respectively were obtained from "Autumn spear calabrese". However, total chlorophyll was not significantly affected by cultivars. Similar general effects of chlorophyll a and chlorophyll b on 23 *Brassica oleracea* cultivars were also presented by Kopsell *et al.* (2004).

According to our experiment, it can be concluded that broccoli cultivar responded differently to the environmental conditions of Sulaimani governorate, and this crop could be grown successfully. Late purple sprouting was the best performing cultivars which the productivity was superior to Autumn spear calabrese, Corvet-F1 calabrese and Hydra-F1 calabrese with the ratio 1.99%, 16% and 50.7%, respectively.

**Table (2): Effect of broccoli cultivars on some reproductive growth and yield characteristics .**

Cultivars	Head fresh weight. plant <sup>-1</sup> (g)	Head dry weight. plant <sup>-1</sup> (g)	Head dry matter %	Head width (cm)	No. of lateral heads. plant <sup>-1</sup>	Weight of lateral heads. plant <sup>-1</sup> (g)	Total plant yield (g)	Total yield ( t .ha <sup>-1</sup> )	Seed weight . plant <sup>-1</sup> (g)	Time to harvest (days)
Autumn spear calabrese	276.1	16.84	8.38	11.72	6.27	173.67	449.7	12.41	26.10	166.6
Hydra-F1 calabrese	122.9	10.13	8.57	9.46	3.42	101.54	224.5	6.23	30.06	162.1
Late purple sprouting	221.4	17.51	8.08	9.68	8.89	234.56	455.9	12.66	33.92	196.1
Covet-F1 calabrese	228.7	24.99	9.30	13.64	5.60	171.94	382.7	10.63	41.12	188.8
Significance R.LSD	110.3*	4.61*	N.S.	2.15**	N.S.	84.17*	161.82*	4.42*	9.61*	6.16*

**Table (3): Effect of broccoli cultivars on some chemical characteristics.**

Cultivars	Chlorophyll a (mg.g <sup>-1</sup> )	Chlorophyll b (mg.g <sup>-1</sup> )	Total chlorophyll (mg.g <sup>-1</sup> )	Ascorbic acid (mg.100g <sup>-1</sup> )
Autumn spear calabrese	0.71	0.36	1.06	84.25

Hydra-F1 calabrese	0.91	0.46	1.37	84.00
Late purple sprouting	0.86	0.42	1.28	85.00
Covet-F1 calabrese	0.75	0.37	1.07	87.93
Significance R.LSD	0.17**	0.09**	N.S.	N.S.

N.S. Not significant \* Significant at ( P= 0.05) \*\* Significant at ( P= 0.01)

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### مقارنة اربعة اصناف من البروكولي في محافظة السليمانية

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### الخلاصة

اجريت التجربة لمقارنة اصناف مختلفة من البروكولي خلال ايلول /٢٠٠٦-حزيران ٢٠٠٧/ في حقل اوباره ، قسم البستنة ، صممت التجربة بتصميم القطاعات العشوائية الكاملة (CRBD) ، تضمنت (٤) معاملات والتي مثلت (٤) اصناف من البروكولي ، Corvet F1 ، Late "Autumn spear calabrese" ، calabrese" ، Hydra-F1-Calabrese و "purple sprouting" وباربع مكررات. وتم مقارنة المتوسطات حسب اختبار اقل فرق معنوي معد(R. LSD) عند مستوى ١% لنتائج التحليل الكيمايية و ٥% للقياسات التجريبيية في التجارب الحقلية.

اظهرت نتائج التجربة بان الصنف ( Late purple sprouting ) اعطى اعلى معدلات ارتفاع النبات و الوزن الجاف للنبات و عدد الافرع الجانبية ووزن الاقراص الجانبية والحاصل الكلي للنبات وحاصل الهكتار الواحد، بينما اعطى الصنف (Corvet-F1 calabrese) اعلى معدل لعدد الاوراق و وزن الاوراق و مساحة الاوراق و الوزن الجاف للقرص و قطر القرص ووزن البذور، في حين ان اعلى نسبة مئوية للوزن الجاف للنبات و كلوروفيل a و اقل فترة للحصاد حصلت من الصنف (Hydra-F1 calabrese) و اعلى معدل للوزن الطري للقرص و كلوروفيل b حصلت من الصنف (Autumn spear calabrese).

**الكلمات المفتاحية:** البروكولي، الأصناف، المقارنة.