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OPPORTUNITIES FOR THE PRODUCTION OF CERTAIN CABBAGES IN OPEN FIELDS DURING THE WINTER MONTHS IN A MODIFIED MEDITERRANEAN CLIMATE

SUMMARY

Climate conditions in the Zeta Valley allow cabbage growing in open fields all year round. Cabbage varieties for winter production have a long vernalisation stage, and they are resistant to temperatures of –10 ^{0}C. If the temperature is lower than –10 ^{0}C for more than a few days, significant damage can be caused to the cabbage. Frosts of –10 ^{0}C are very rare in the Zeta Valley, with a probability of occurring once every 10 years, mostly in January or February.

We investigated the possibility of growing winter cabbage, brussels sprouts and broccoli in an open field in the Zeta Valley in two-year long (cabbage and broccoli) and three-year long (brussels sprouts) experiments. The parameters examined were the type or variety and planning date. We also examined the influence of temperature on the cabbage heads and the cabbages' weight, number of damaged leaves, technical maturity and total yield for three varieties (Bartolo $F_{1,}$, Saratoga F_1 and Hidena F_1) from the Dutch seed production company Beji-Zaden on three planting dates (July 15, July 27 and August 13). The results showed that cabbage can be successfully cultivated in an open field during the winter season in the Zeta Valley, with satisfactory results obtained for all of the four varieties. They also demonstrated that the optimum planting time for cabbage is the end of July.

Our main aim was to investigate the possible introduction of broccoli in the Zeta Valley, an area where broccoli is not well known. The vegetation period, the data on top and side inflorescences and their characteristics and total yield were investigated. The weight, diameter and compact of inflorescences and the length of the blossom branch were measured.

The vegetation period varied from 112–127 days. The average time to harvesting of the top inflorescences and the side inflorescences was 24 days and 35 days, respectively. The diameter of the top inflorescence was 12.6–17.6 cm, the length of blossom branch was 3.8–4.3 cm and the compactness was 2–3 (scale 0-5). The diameter of the side inflorescence was 5.7-9.4 cm, the length of the blossom bough was 4.6-5.0 cm and the compactness was 3 (scale 0-5). The weight of the top inflorescence ranged from 294.50 to 312.64 g, and the yield ranged from 10.90 to 11.57 t/ha. The side inflorescences weighted were from 95.4 to 114.8 g, and the yield was 14.08-19.11 t/ha. The total yield depended on cultivar and varied from 24.98–30.64 t/ha.

On the basis of these results, we conclude that the Zeta Valley area has favourable agro-ecological conditions for broccoli growth.

Keywords: cabbage, brussels sprouts, broccoli, hybrid, planting period, quality, yield

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INTRODUCTION

Winter production of cabbages requires transplantation in July–August. Shorter days in the autumn and lower temperatures create conditions for vernalisation and cabbage flowering (Isenberg et al., 1974). Therefore, for winter production in Mediterannean regions, it is necessary to select varieties with a long vernalisation period and resistance to frosts. The Zeta Valley has an Adriatic type of Mediterranean climate, which is significantly modified by the influence of high surrounding mountains. The average annual temperature is 15.5 ^{0}C. The region experiences sunny and warm summers and cold, wet winters, with a possibility of frosts of -10 ^{0}C (temperature at which cabbage and brussels sprouts can survive without any significant damage) once every 10 years., The annual rainfall is around 2,000 mm (Pavicevic, 1983). The climate data show that winter production of cabbages in open fields in the Zeta Valley is possible. However, to achieve successful successive harvests in the winter, appropriate cabbage families must be selected and the optimum planting dates and variety assortments for the given agro-ecological conditions must be defined.

MATERIAL AND METHODS

We investigated the possibility of growing winter cabbage, brussels sprouts and broccoli and determined the most favourable hybrids for the agro-ecologic conditions of the Zeta Valley intwo-year long (cabbage and broccoli) and three-year long (brussels sprouts) experiments. The factors investigated were the variety and planting dates. The research included three hybrids of cabbage (Bartolo F_1, Saratoga F_1i and Hidena F_1) and three planting dates (15 July, 29 July 29 and 13 August), two brussels sprout varieties (Diablo F_1 and Harley F_1) with four planting dates (10 April, 10 May, 10 June and 10 July) and five hybrids of broccoli (Lucky F_1, Fiesta F_1, Montop F_1 and Monterey F_1), all of which were transplanted on August 13. The experiment was performed according to the split-plot method in three repetitions, as we monitored the influence of assortment and planting dates on the marketing qualities (weight and density of heads and dry matter content) and the total yield. The density of the heads was measured on the basis of a visual assessment (grades 0–5), and the dry matter content was measured using the calcination method at 105 ^{0}C.

RESULTS AND DISCUSSION

A suitability assessment of certain cabbage, brussels sprouts and broccoli species for winter production in the Zeta Valley was performed to determine the influence of type and planting date on the amount and quality of the yield.

Table 1 shows that the cabbage yield was highly dependent on the planting date, with the highest yield (39.5–75.13 t/ha) recorded for the first planting date (39.5–75.13 t/ha) and the lowest yield (21.99–55.83 t/ha recorded for the third date for all of the three varieties analysed. The highest yield was achieved with Bartolo (55.83–75.13 t/ha) and the lowest with Hidena (21.99–39.50 t/ha). The weight of the heads varied from 746.8 g to 2101.7 g, depending on the planting

date and variety. This finding is lower values were recorded by Kling and Wiebe (1991). All of the planting dates resulted in heads of rather good density, but later dates yielded smaller sized heads, which is desirable for varieties intended for fresh consumption. The dry matter content in the analysed samples varied from 9.21 to 10.46%, with a significantly higher content recorded for plants from the third planting date compared with those from the first and second dates. There was no significant difference in the dry matter content between the different varieties. Similar results were previously obtained with the variety Winterduke F_1 in the analysed area (Mirecki, 2001).

The results indicate that winter cabbage can be successfully produced in the Zeta Valley area but that the variety Bartolo should be favoured other types. They also suggest that early planting dates are necessary to obtain bigger heads and that later planting dates are warranted if the market demands smaller heads.

Table 1. Yield and quality of cabbage

Planting date (A)	Cultivar (B)		Yield (t/ha)	Weight of head (g)	Density of head (0-5)	Dry matter (%)
I	Bartolo F_1		75,13	2101,7	4	9,66
	Saratoga F_1		65,99	2006,4	4	8,94
	Hidena F_1		39,50	1627,0	4	9,04
II	Bartolo F_1		55,10	1507,5	4	9,09
	Saratoga F_1		56,89	1515,6	4	9,45
	Hidena F_1		21,78	1566,0	4	9,99
III	Bartolo F_1		55,83	1244,5	4	10,45
	Saratoga F_1		35,17	1045,5	4	10,53
	Hidena F_1		21,99	746,8	4	10,41
LSD	A	1%	3,86	272,86		0,31
		5%	2,55	187,55		0,18
	B	1%	3,54	308,07		0,36
		5%	2,58	227,34		0,26

Table 2. Yield and quality of brussels sprouts

Planting date (A)		Variety (B)	Total Yield (t/ha)	Weight of sprouts (g)	Density (0-5)	Dry matter (%)
I		Diablo F_1	19,93	8.70	3	12,87
		Harley F_1	20,90	8.13	4	12,97
II		Diablo F_1	18,07	7.74	3	13,38
		Harley F_1	16,73	7.62	3	13,09
III		Diablo F_1	16,30	8.46	3	11,41
		Harley F_1	12,60	8.00	3	11,26
IV		Diablo F_1	14,77	8.97	4	12,51
		Harley F_1	13,37	8.86	4	10,95
LSD	A	1%	0,64	0.44		2,74
		5%	0,42	0.29		1,48
	B	1%	0,63	0.23		0,89
		5%	0,43	0.16		0,61

Table 2 shows values for the achieved yield (13.37 to 20.92 t/ha) for brussels sprouts within the three-year long study. Differences in yield with respect to the planting dates and assortments were statistically very significant. Yields achieved with the first planting date (19.93–20.90 t/ha) were higher than with he second planting date (16.73–18.07t/ha). The third and fourth planting dates realised lower yields (a highly significant difference), although the weight (7.62–8.97 g) of the sprouts increased with the later planting dates. The difference in yields for the fourth planting date was statistically very significant compared with those for the first date. This finding can be explained by the lower total number of formed sprouts (Mirecki, 2005). The results are in accordance with those of Sotlar et al. (1988) and Černe (1992). Bowen et al. (1995) reported that sprouts of lower weight were obtained at later planting dates.

Sprouts with a good density (sturdy) are sold as fresh, whereas those with a lower density or those that open are processed. In our experiments, the density was evaluated visually (grades 0–5) and varied from 3–4, but sprouts with \ better density were obtained with the later planting dates.

The dry matter content of the brussels sprouts varied from 10.95 to 13.38% and was dependent on the planting date, which is in accordance with the results of Abuzeid and Wilcockson (1989) but contrary to the those obtained by Everaarts et al. (1998).

Table 3. Yield and quality of broccoli

Cultivar		Total Yield (t/ha)	Weight of head (g)	Density (0-5)	Dry matter (%)
Lucky F_1		11,53	311,50	2	12,3
Fiesta F_1		10,90	294,67	2	13,3
Montop F_1		11,07	276,84	3,5	11,6
Monterej F_1		13,68	342, 05	4,0	12,8
LSD	1%	0,74	56,9		1,57
	5%	0,65	43,1		1,13

Our study showed that it is possible to successfully grow hybrids of broccoli (*Brassica oleracea var. italica*) with different growing periods (97 to 127 days) but that to avoid any significant damage harvesting must be performed in December before the temperature falls below 0 ^{0}C. The highest yield was achieved with the variety Monterey (13.68 t/ha). There was no statistically significant difference in the yield or in the weight of the heads with the other three varieties. As regards the head density, the varieties Montop and Monterej showed the best results (3.5 and 4), whereas the dry matter content was the highest with the variety Fiesta (13.3).

Compared with the yields reported by Černe et al (1992) and Toth et al. (1998), the yields that we achieved were significantly higher. This could be due to favourable temperature conditions and regular watering. Results presented by Sanders (1996) and Lešić (1990) are in accordance with ours.

CONCLUSION

Our research has shown that the Zeta Valley area is suitable for the production of cabbage and brussels sprouts in the winter months in open fields and that broccoli, transplanted in August, can be planted once it is harvested before December before the first winter frosts. The interaction between the observed parameters was very important, indicating that environmental conditions (planting date and year climate conditions) and cultivation manner (selection of varieties) have a significant impact to the yield.

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MOGUĆNOST PROIZVODNJE NEKIH KUPUSNJAČA NA OTVORENOM POLJU U TOKU ZIMSKIH MJESECI U USLOVIMA IZMJENJENE MEDITERANSKE KLIME

SAŽETAK

Zetska ravnica je region sa najintenzivnijom proizvodnjom povrća u Crnoj Gori. Uslovi izmjenjene mediteranske klime omogućavaju proizvodnju nekih vrsta povrća iz porodice Brassicacea, na otvorenom polju tokom cijele godine. U radu su prikazani rezultati ispitivanja mogućnosti gajenja kupusa, kelja pupčara i brokole za zimsku proizvodnju.

Ispitivana su tri hibrida kupusa (Bartolo, Saratoga, Hidena) u tri roka sadnje (15.VII, 29.VII i 13.VIII), kao i dva hibrida kelja pupčara (Diablo i Harley) u četiri roka sadnje (10.IV, 10.V, 10.VI, 10.VII) i četiri hibrida brokole (Lucky, Fiesta, Montop i Monterey) rasađivanih 13.VIII. Kod navedenih vrsta povrća praćen je uticaj sorte i roka sadnje na kvalitet (masu, zbijenost glavice i sadržaj suve materije) i visinu prinosa.

Ključne riječi: kupus, kelj pupčar, brokola, hibrid, rok sadnje, kvalitet, prinos.