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Pepper Seed Yield and Quality in Relation to Fruit Position on the Mother Plant

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Abstract: Variation in seed yield and quality in relation to fruit position were determined in hot pepper cultivar during 2004 and 2005. Fruits were harvested from different layers (first, second and third) of the plant. In each layer, fruits were harvested 65 days after anthesis to obtain similar seed maturation stage. Fruit weight, seed yield, seed moisture content, germination at 15 and 25°C, germination after controlled deterioration and mean germination time were determined. Fruit weight and seed yield gradually decreased throughout fructification, from the first to the third layer. Seed moisture content did not change between layers. Moisture remained at values of about 48-50%. The seeds extracted from fruits of the first layer had higher germination and vigour, lower mean germination time than those from the other layers. Seeds from the third layer caused decline in seed quality especially vigour with 69.3%.

Key words: Pepper, fruit position, seed quality, seed yield

INTRODUCTION

The main aim in a seed production programme is to obtain maximum seed quality. There are variation among species in occurrence of maximum seed quality during development and its association with seed and fruit characteristics. Apart from seed development stage the quality of seed depends on various factors such as cultural practices, climatic conditions and fruit position on the mother plant (Passam *et al*., 1997). In a seed lot, seeds can have experienced different histories according to their anthesis date, their own environment (i.e., assimilate or micro-climate) and changing environment of the mother plant (Coste *et al*., 2001). Several studies with species such as melon (Incalcaterra and Caruso, 1994), carrot (Nagarajan *et al*., 1998) and tomato (Dias *et al*., 2006b) have shown that fruit position on the mother plant can lead to differences in seed size and viability. In pepper, previous studies are contradictory in this respect. Osman and George (1984) reported that seeds obtained from lower level on the plant giving the highest mean seed weight, germination and shortest time to germination and seedling emergence. On the other hand, Demir (1991) reported that there are no significant differences in seed quality between layers.

In plant species of indeterminate growth, such as pepper, tomato, the buds, flowers and fruits develop progressively on the same plant due to continuous flowering and fructification. Thus, the fruits on a plant compete strongly with each other and the vegetative plant parts for the available assimilates (Ali and Kelly, 1992). This competition for available assimilates affect subsequent fruit size, seed quality and number (Stephenson *et al*., 1988; Marcelis and Baan Hofman-Eijer, 1995).

Thus, the pepper seed quality can vary according to fruit position on the mother plant. There are disagreements about position on the mother plant and seed quality in pepper. This study was carried out to determine the effect of fruit position on seed quality and yield in a hot pepper cultivar.

MATERIALS AND METHODS

Cultivars and growing conditions: The pepper (*Capsicum annuum* L.) cultivar Ilıca-256 was grown under field conditions in Turkey, at Ege University, Ödemis Vocational Training School during 2004-2005. Seeds were sown on 20 (2004) and 25 (2005) February in trays. Then, seedlings were transplanted to the field in a spacing of 70×35 cm on 29 April in 2004 and 19 April in 2005. The experimental design was a randomized complete blocks. Each treatment was replicated fourth times, with 30 plants in each replicate. Plants were fertilized with equivalent to 120 kg N, 150 kg P_2O_5 and 200 kg K_2O per hectare (Raymond, 1999) during growing season. The furrow

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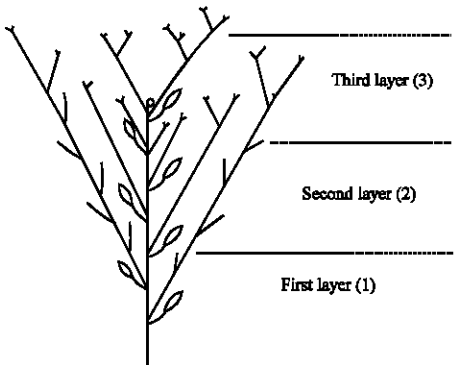

Fig. 1: Position of harvested pepper fruits

irrigation was applied as needed and other cultivation practices were conducted. The average maximum and minimum temperatures during the whole growing season were 15 and 40°C. The soil was sandy loam (69% sand; 24% loam; 7% clay) with 1.6% organic matter and pH 7.3.

Harvest: Flowers were tagged almost daily at anthesis without removing any flower from the first, second and third layer (Fig. 1). Three harvest layer were considered due to unavoidable seasonal factors. Ten days tagged periods were used for each layer from June 15 to July 15 in 2004 and from June 5 to July 5 in 2005. Fruits for seeds were harvested 65 days after anthesis to provide similar seed development stage. Because of the unexpected weather conditions, fruits from the third layer could not be harvested in 2005. Fruit weight (g), fruit length (cm) and fruit diameter (cm) were recorded for each treatment with the average of twenty fruits randomly selected. Fruit length was measured from bottom to top of fruit that under fruit stalk. Fruit diameter was measured under fruit stalk where the widest part of the fruit. Seeds per fruit was counted with the average of twenty fruits randomly selected. Then fruits were cut and seeds were extracted by hand and seed moisture content was determined by the low-constant temperature oven method (ISTA, 1999). Immediately afterwards, seeds were surface dried to < 8% moisture content on blotting paper in the shade for three to four days. Then, sealed in glass jars and stored at 5°C. Seed yield was determinated in kg ha^{-1} with total weight of seeds after extraction.

Germination tests at different temperatures: Germination tests were carried out on four replicates of 100 seeds that previously moistened with 0.2% KNO_3 solution, at temperatures of 15 and 25°C in petri dishes and in the dark on the filter paper for 14 days. Each replicate contained double line paper. Germination was considered to have occurred when the radicle is 2 mm long. Germinating seeds were counted one day interval and mean germination time was calculated.

Seed Vigour: Seed vigour was assessed by a controlled deterioration test at 24% moisture content in water bath at 45°C for up to 24 h (Kavak *et al*., 2004, 2005). After controlled deterioration, four replications of 100 seeds were germinated at 25°C as described above.

Analysis of variance was carried out using SAS statistical program (SAS, 1996) and mean differences were determined by LSD test. For germination and seed moisture content, analysis of variance was performed on arcsin transformed percentage data.

RESULTS AND DISCUSSION

Fruit weight, fruit length and fruit diameter were significantly affected by fruit position on the mother plant in both years (Table 1). The highest fruit weight was obtained from the first layer with a weight of 11.1 g in 2004 and 15.4 g in 2005. Fruit weight gradually declined throughout fructification, from the first to the third layer as did fruit length and diameter. Fruits from the first layer produced larger fruit than the other layers. Similar results were also reported by Bertin *et al*. (1998) and Dias *et al*. (2006a) in tomato. According to Guillaspy *et al*. (1993), the fruits located on late trusses tend to be smaller and lighter, due to less number of cells and low capacity to compete for photo-assimilates. These decreases can be explained that the presence of a developing fruit can inhibit subsequent fruit set and growth. This inhibition may be caused by competition for available assimilates, by dominance due to production of plant growth regulators from the developing fruit, or by a combination of competition and dominance (Stephenson *et al*., 1988; Bangerth, 1989).

Seed number per fruit and seed yield were also affected by fruit position during 2004 and 2005. Seeds from first and second layer had similar results (101 and 98 seeds, respectively) and produced more seeds than third layer (68 seeds) in 2004 (Table 2). In second year, the lowest seeds per fruit was recorded with 86 seeds from second layer. Maximum seed yield was attained from fruits of first layer with 390 kg ha^{-1} in 2004 and 411 kg ha^{-1} in 2005. Seed yield gradually declined as fruit weight, from the first to the third layer in both years. The fruits from third layer had the lowest seed yield with 125 kg ha^{-1}. Seed moisture content were not significantly affected by fruit position and varied between 47 and 49%.

The results of the fruit weight and seed yield have showed that fruits from the upper layer caused

Table 1: The effect of fruit position on fruit characteristics

	Fruit weight (g)		Fruit length (cm)		Fruit diameter (cm)	
Fruit position	2004	2005	2004	2005	2004	2005
1	11.1a	15.4a	16.3a	19.6a	1.5a	1.7a
2	8.0b	9.5b	14.2b	16.2b	1.1b	1.2b
3	6.5c	*	13.9b	*	1.1b	*
LSD (5%)	1.1	1.1	0.5	0.7	0.1	0.1

Within each column, same letter indicates the absence of significant differences at p = 0.05, *: No harvest

Table 2: The effect of fruit position on seed yield

	Seeds per fruit		Seed yield (kg ha^{-1})		Seed moisture content (%)	
Fruit position	2004	2005	2004	2005	2004	2005
1	101.0a	109.0a	390.00a	411.0a	49.0 (44.89)	49.4 (44.66)
2	98.0a	86.0b	226.14b	253.0b	49.0 (44.43)	47.6 (43.62)
3	68.0b	*	125.38c	*	47.8 (43.76)	*
LSD (5%)	5.2	14.6	5.7	3.3	NS	NS

Within each column, same letter indicates the absence of significant differences at p = 0.05, NS: Non-significant, Values in parentheses are arcsine values, *: No harvest

Table 3: The effect of fruit position on seed germination and vigour

	Germination (%) at 15°C		Germination (%) at 25°C		Vigour (%)	
Fruit position	2004	2005	2004	2005	2004	2005
1	87.0a (68.9)	89.5a (71.2)	91.5a (73.2)	97.8 (81.6)	84.0a (66.5)	87.5a (69.4)
2	85.5a (67.8)	80.5b (63.9)	86.0b (68.0)	98.5 (83.1)	79.0b (62.8)	74.0b (59.4)
3	80.5b (63.9)	*	81.8c (64.8)	*	69.3c (56.3)	*
LSD (5%)	3.4	4.9	2.7	NS	0.5	6.5

Within each column, same letter indicates the absence of significant differences at p = 0.05, *: No harvest, Values in parentheses are arcsine values

a reduction in fruit weight during the fructification period. Because of this, the decrease in seed yield can be related to the fruit weight. Khah and Passam (1992) and Shipp *et al.* (1994) have also reported that in pepper fruit size and fruit set have been positively correlated with seed number. According to Marcelis and Baan Hofman-Eijer (1997), seed number may affect fruit set and as fruits compete with each other for the available assimilates, seed number may also affect growth of individual fruits indirectly via an effect on the number competing fruits. The moisture content during seed development, in most fleshy vegetables like tomato and pepper (Demir and Ellis, 1992a, b) generally varied between 38-45%.

In general, seed germination percentages (at 15 and 25°C) were significantly influenced by fruit position on the mother plant (Table 3). At 15°C, the seeds extracted from first (87.0%) and second layer (85.5%) had higher germination percentages than third layer (80.5%) in 2004. In second year of the study, maximum seed germination was attained from the first layer with 89.5%. At 25°C, seeds from first layer showed the highest germination with 91.5%, whereas seeds from second and third layer with 86.0, 81.8%, respectively in 2004. However, germination percentages were not significantly affected by fruit position at optimum temperature in 2005. The controlled deterioration test showed that there were significant differences in vigour between layers in both years (Table 3). In the first year, seeds from first layer attained maximum vigour with 84%, whereas seeds from the second and third layer with 79.0 and 69.3%, respectively. In the second year, deterioration test gave similar results as first year. Maximum vigour was recorded from first layer as 87.5% and then declined to 74.0% in the second layer. Depending, fruit position, there was a considerable reduction in vigour.

Table 4: The effect of fruit position on mean germination time

	Mean germination time (day) at 15°C		Mean germination time (day) at 25°C	
Fruit position	2004	2005	2004	2005
1	16.9a	16.0	4.9b	4.8
2	14.9b	16.3	5.5a	4.8
3	15.3b	*	5.6a	*
LSD (5%)	0.4	NS	0.2	NS

Within each column, same letter indicates the absence of significant differences at p = 0.05, NS: Non Significant, *: No harvest

Mean germination time (at 15 and 25°C) was also significantly affected by fruit position in 2004 but differences were not significant in 2005 (Table 4). At low temperature, the lowest germination time was recorded from second layer as 14.9 day. Seeds from first layer increased germination time with 16.9 days. At 25°C, seeds from first layer had lower mean germination time with 4.9 day, compared to the seed from second and third layers (5.5 and 5.6 day, respectively) at 25°C.

The effect of the fruit position on seed quality indicated that seeds from first layer had higher germination and vigour percentages and lower mean times

to germination except at 15°C. Similar results were also reported by Osman and George (1984) in pepper, Mavi and Sermenli (2002) in eggplant and Incalcaterra and Caruso (1994) in melon. On the other hand, Demir (1991) indicated that seeds obtained from first and second layer did not show significant differences between layers in California Wonder pepper which has large fruited types. Also, Dias *et al.* (2006a) reported that high vigour seeds obtained from the late trusses with smaller fruits in tomato. This differences may be based on cultivars or climatic conditions. Bertin *et al.* (1998) suggested that climatic conditions during plant growth and photo-assimilates supply as determined by the source/sink ratio during fructification may also affect fruit size and weight, together with fruit location on the plant and the sequence of truss formation.

It can be concluded from the present work that fruit weight, seed yield and quality especially vigour decreased from the first to the third layer in hot pepper. Seeds should be harvested from first layer for maximum germination and vigour. Further research is required to check if these ideas are also valid for different climatic conditions and other cultivars which has different fruit shape in pepper.

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