The effect of organic fertilizers and thinning methods on quality parameters and the yield on apple cultivars ‘Aroma’ and ‘Discovery’ in Norway

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**Implications**

The novelty of this work was to find out how does different organic fertilizers and the thinning methods influence the quality parameters and the yield of apple (*Malus* x*domestica*) cultivars ‘Discovery’ and ‘Aroma’ grown in Norway, Hardanger region.

Both fertigation type and thinning method showed significant effect on weight and quality analyses of both cultivars. The thinning method had stronger effect on apple weight and the fertigation type influenced more the apple quality parameters.

**Background and objectives**

In Norway, apple growers are focusing in medium sized apples suitable for 6-pack consumer packages. ‘Aroma’ can have an excessive and uneven fruit set and therefore there is a growing need to find out method to reduce the fruit size of ‘Aroma’. ‘Discovery’ is rather small-fruited cultivar, hence more even and bigger fruit size is desired. In our study, different thinning methods with two different types of organic fertilizers were used to influence the fruit size and the yield. Our hypothesis was that organic fertilizers provide optimal nutrient ranges during the growing season to both cultivars and have a positive effect on the yield and quality parameters. However, organic fertilizers tend to have slow nitrogen release in the beginning of the season, while synthetic fertilizers can provide optimal levels of nutrients. In our experiment, two different organic fertilizers with two fertigation levels were used: pelleted fertilizer Marihøne Pluss 8–4–5 (chicken manure, meat bone meal and vinasse) and liquid fertilizer Pioneer Hi Fruit 4–1–5 (organic plant material, natural minerals, extracts of sugarcane and potato).

**Key results and discussion**

Both organic fertilizers and the thinning methods had significant effect on the weight and on quality parameters on both cultivars ‘Aroma’ and ‘Discovery’. Since there was clearer tendency with cultivar ‘Aroma’, its results on fruit quality parameters are mainly discussed here. There was significant effect on weight with the strong thinning in the ‘Aroma’ orchard rather than fertigation type in 2016. Pelleted fertilizer Marihøne Pluss 60 kg N/ha with strong thinning gave highest results in weight (337,6 g per fruit) when compared to same fertigation type’s weak thinning (290,1 g), to Pioneer Hi fruit 60 kg N/ha weak thinning (273,9 g) and to 30 kg N/ha Marihøne Pluss with weak thinning (248,3 g). Same trend was followed in ‘Discovery’ orchard in 2016, where most of the strong thinning replications had heavier apples compared to weak thinning. Thus, highest weight in ‘Discovery’ orchard was with Marihøne Pluss 30 kg with strong thinning (152,4 g per fruit) when compared to other weak thinning results in the trial, except with Pioner Hi Fruit 30 kg N/ha with weak thinning (139,3 g).

IAD index was highest with the liquid fertilizer Pioner Hi Fruit 60 kg N/ha (Pioner 60 in Table 1) with both thinning types (IAD index 1,28 for both) when compared to the control’s weak and strong thinning results (IAD index 1,0 and 0,90; respectively) in the ‘Aroma’ orchard in 2016 (Table 1). Similar trend was observed with starch results where Pioner Hi fruit 60 kg N/ha strong thinning had significantly higher starch content (8,5 in 1–9 scale) when compared to control’s weak thinning starch content (7,2 in 1–9 scale). Marihøne Pluss 30 kg N/ha with strong thinning (Marihøne 30 strong in Table 1) had firmer apples (6,21 kg.cm-2) when compared to control’s strong thinning (5.55 kg.cm-2) and to Pioner Hi Fruit 30 kg N/ha (5.67 kg.cm-2) (Pioner 30 strong in Table 1). There was no significant difference in soluble solid content (SSC) between the fertigation types neither with thinning. Although, there was higher titratable acid (TA) with Marihøne Pluss 60 kg N/ha (1,02) when compared to control’s weak thinning results (0,82%). IAD index and starch content concludes that Pioner Hi Fruit 60 kg/ha apples were less ripen compared to the control.

Table 1. Effect of different fertigation types and thinning methods on cultivar ‘Aroma’ quality parameters (2016).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | IAD index | Starch (1-9 scale) | Firmness (kg.cm2) | SSC(% °Brix) | TA(%) |
| Control weak | 1.00 bc | 7.20 bcd | 6.15 ab | 12.93 a | 0.94 ab |
| Control strong | 0.90 c | 8.05 abcd | 5.55 b | 12.63 a | 0.82 b |
| Marihøne 30 weak | 1.05 bc | 7.58 abcd | 6.21 a | 12.83 a | 0.94 ab |
| Marihøne 30 strong | 1.03 bc | 7.35 cd | 5.87 ab | 13.25 a | 0.91 ab |
| Marihøne 60 weak | 1.12 b | 8.05 abcd | 5.88 ab | 12.56 a | 0.88 ab |
| Marihøne 60 strong | 1.17 ab | 7.26 d | 5.89 ab | 13.08 a | 1.02 a |
| Pioner 30 weak | 1.14 ab | 8.13 abcd | 5.86 ab | 12.98 a | 0.92 ab |
| Pioner 30 strong | 1.12 b | 8.20 abc | 5.67 b | 12.38 a | 0.93 ab |
| Pioner 60 weak | 1.27 a | 8.36 ab | 5.86 ab | 12.70 a | 0.99 ab |
| Pioner 60 strong | 1.28 a | 8.49 a | 5.84 ab | 12.42 a | 0.90 ab |

Means followed by different letters within the same column are significantly different at p<0.05.

**How work was carried out?**

Experiment was carried out in 2015-2016 in Ullensvang municipality, where most of the inhabitants live in narrow coastal mountainsides and valleys along Hardangerfjord. The most popular apple cultivars in the area, ‘Aroma’ and ‘Discovery’ were selected to the study. Apple trees ‘Aroma’/M9 were planted in autumn 2010 with 4,5x1 m spacing in the Lofthus village, Hordaland (60°19'12.8"N 6°39'12.7"E). Pollinizer tree in ‘Aroma’ orchard was cultivar ‘Kobenza’ and area classifies as a flat. ‘Discovery’ field situates in the steep area in the Jåstad village (60°20'36.7"N 6°37'16.3"E). ‘Discovery’/M9 orchard was planted 2011, with planting space 3,5x0,9 m. Fertigation was carried out twice a week two weeks before blooming (apples start to bloom in the middle of May in Norway). Ground fertilizer was pelleted organic fertilizer Marihøne Pluss 8–4–5 with the fertigation rate 30 kg N/ha. Thinning method used in the trial was strong (15 cm between the fruit) and weak thinning (15 cm after 1 or 2 fruit). Fertilizers used in our trial were organic pelleted fertilizer Marihøne Pluss 8–4–5 (chicken manure, meat bone meal and vinasse) and organic liquid fertilizer Pioner Hi Fruit 4–1–5 (organic plant material, natural minerals, extracts of sugarcane and potato). In 2015 the fertigation rate was 15 and 30 kg N/ha with both fertilizers. In 2016 the N rate was 30 and 60 kg N/ha. Control did not have any additional fertigation in both years. Experimental design was a randomized complete block with four replications. Firmness was determined by penetrometer (Fruit texture analyser Güss 84 Jennings, South Africa) on opposite sides of each fruit and results were expressed as kg.cm-2. Chlorophyll absorbance index (absorption difference between 670 and 720 nm) indicating chlorophyll content IAD was measured by DA meter (Model FRM01, Forli, Italy). Soluble solid content SSC was measured by a refractometer (Atago, Japan) and were expressed as °Brix. Titratable acid TA was analysed by titration of fruit juice as malic acid with 0.1M NaOH to pH 8.1 (Radiometer-analytical titrationmanager TIM865 with sample changer SAC850, Germany) and the results were expressed in %. Starch score was assessed in an iodine solution and let stand more than 1 minute before evaluation and it was expressed in 1–9 scale, where 1=full staining, 9=free of starch. Statistical analyses were done by One-way analysis of variance (ANOVA). Statistical significance was considered at p<0.05 using Tukey’s test by using Minitab 17.2.4.0 (Minitab Ltd., State College, PA, USA).