

Effect of nitrogen, planting distance and time of harvest on yield and fruit quality of elderberry (*Sambucus nigra* L.)

Virkning af kvælstoftilførsel, planteafstand og høsttidspunkt på frugtudbytte og frugtkvalitet hos hylde (Sambucus nigra L.)

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Summary

A factorial experiment with four levels of nitrogen supply, three planting distances, and three harvest times was carried out to study the effect on fruit yield and fruit quality of elderberry (*Sambucus nigra* L.). The yield per bush was influenced by planting distance, nitrogen level, and bush growth with years.

The content of soluble solids, titratable acids and anthocyanins was not affected by levels of ni-

trogen but by harvest time. A high plant density and 300–400 kg N/ha with a planting distance of 1 m in the row and 4–5 m between the rows are recommended for the first three growing seasons. To obtain a high content of anthocyanin, which is valuable in the use of elderberry juice as a colour ingredient the harvest may have to be delayed almost to the overripe stage but before development of an »over-ripe« flavour.

Key words: Elderberry, nitrogen supply, planting distance.

Resumé

Med hylde (*Sambucus nigra* L.) er udført et faktorielt forsøg med fire kvælstoftrin, tre planteafstande og tre høsttider.

Formålet har været at bestemme frugtudbytte og frugtkvalitet ved varierende kvælstofgødskning, planteafstand og høsttidspunkt.

Resultaterne af de første tre udbytteår har vist, at en høj plantetæthed og anvendelse af 300–400 kg N/ha kan anbefales i hyldeplantager.

Ved kraftig beskæring hvert år opnås, at planterne holdes i buskform, hvor skærmene udvikles

på etårige skud, hvorfra de let kan plukkes.

Indholdet af opløseligt tørstof, titrerbar syre og farvestof (anthocyaniner) påvirkes ikke af den anvendte kvælstofmængde, men er stærkt afhængig af høsttidspunktet.

Det optimale høsttidspunkt er 10–14 dage efter, at der er konstateret 90 pct. sorte bær i skærmene. Derved opnås et højt indhold af farvestof, som er vigtigt, fordi hyldebærsaft ofte anvendes som ingrediens ved fremstilling af blandede frugtsafter og vinsæt.

Nøgleord: Hylde, kvælstofgødskning, planteafstand.

Introduction

The literature on planting density and levels of nitrogen for elderberry orchards is limited. In some cases a yearly supply of nitrogen may be as high as 200–400 kg N/ha (4, 7, 8).

The aim of this experiment was to study the effect of harvest time, nitrogen level and planting distance on yield and fruit quality.

Materials and methods

The experiment was factorial with four levels of nitrogen (100, 200, 300, 400 kg N/ha), three planting distances in the rows (1, 2, 3 m) and harvest at three stages of maturity at 1, 7 or 14 days after occurrence of 90 p.c. black fruits in the umbels.

Two year old bushes of the variety 'Sambu' were planted in November 1983 with a row distance of 5 m and with 4 m of grass between the rows.

To promote cross pollination (6), other varieties were planted between plots of nitrogen levels and around the elderberry orchard.

The grass was cut 4–5 times each year. Weed control was carried out using Simazin (3 l/ha), Kerb (2 kg/ha) and Gramoxone/ Reglone (2 l/ha).

500 kg/ha NPK (0-4-21) and 50 p.c. of the nitrogen were applied as Ca (NO₃)₂ at the beginning of March and the rest at the beginning of July.

Attack of *Gloesporium fructigenum* was prevented by the use of Captan during the latest part of fruit development.

The plants were pruned each year. Branches two years old were removed and umbels developed on one year old 1–3 m long branches. Six bushes from each combination were harvested on day 1, 7 and 14 respectively. On harvest day 1 the majority of umbels had 90 p.c. black fruits. Samples of 30–40 umbels (3–4 kg) were used to determine average umbel weight. After stripping and mixing the fruits, 600 g were used for analysis.

Table 1. Average umbel weight (1985–1987) at four levels of nitrogen supply and three planting distances. Total average 116 g/umbel.

Skærmvægt i gennemsnit for kvælstoftrin og plan-teafstande. Totalgennemsnit 116 g/skærm.

| Nitrogen kg/ha | 100 | 200 | 300 | 400 | LSD |
|----------------|-----|-----|-----|-----|-----|
| g/umbel | 101 | 112 | 122 | 127 | 17 |
| Distance, m | 1 | 2 | 3 | | |
| g/umbel | 110 | 110 | 125 | | 15 |

Soluble solids were determined by refractometry and expressed as g/100 g. Titratable acid in fruits was determined by titration with 0.1 N NaOH to pH 8.1 and calculated as g/kg of citric acid. Anthocyanins were extracted with 0.01 p.c. HC1/MeOH and absorbance was measured at 530 nm. The content of anthocyanins was expressed as mg cyanidin-3-glucoside per 100 g of fruits.

Results

At 1 m planting distances a hedge is established after 2–3 years. At planting distances of 2–3 m a hedge was not established even in the third growing season.

Average bush height increased from 0.9 m in 1984 to 2.7 m in 1987. It was lowest at the 100 kg/ha level of nitrogen and was unaffected by planting distance. Bush width increased from 0.6 m in 1984 to 2.5 m in 1987. The bush width was also unaffected by planting distance.

Umbel weight increased with increasing supply of nitrogen and planting distance (Table 1). The umbel consisted of 90 p.c. fruits and 10 p.c. pedicels/peduncles.

The average yield of umbels was increased in the last two growing seasons (Table 2) by increasing nitrogen level. Optimum harvest time in 1985 and 1986 was the last week of September, and in the middle of October in 1987. This was probably due to unusual weather conditions in 1987.

Average yield/bush increased over the years because of bush growth, and for the last two years by increasing planting distance (Table 3). The harvest date did not significantly affect the yield. Table 4 shows that in 1986 and 1987 a distance of 1 m and the highest level of nitrogen resulted in the largest yield per ha.

Table 2. Yield of umbels per bush at four levels of nitrogen supply in three years. Average of three harvests and three planting distances.

Skærmudbytte, kg pr. busk, ved fire kvælstoftrin i tre år. Gennemsnit for planteafstande og høsttid.

| Year | kg N/ha | | | | LSD |
|------|---------|-------|-------|-------|------|
| | 100 | 200 | 300 | 400 | |
| 1985 | 3.79 | 4.64 | 4.40 | 3.54 | 0.49 |
| 1986 | 5.89 | 7.51 | 9.63 | 9.69 | 0.72 |
| 1987 | 10.24 | 13.57 | 13.76 | 15.91 | 1.57 |

Table 4. Yield of umbels in t/ha at four levels of nitrogen supply and three planting distances for three years. Average of three harvests.

Arealudbytte t/ha ved fire kvælstoftrin i tre år ved tre planteafstande. Gennemsnit for høsttider.

| kg N/ha | 1985 | | | 1986 | | | 1987 | | |
|---------|---------------------|-----|-----|------|------|-----|------|------|------|
| | Planting distance m | | | | | | | | |
| | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| 100 | 8.7 | 3.6 | 2.3 | 7.0 | 5.8 | 5.6 | 10.8 | 8.7 | 11.1 |
| 200 | 9.9 | 4.8 | 2.8 | 9.7 | 7.7 | 6.6 | 13.4 | 14.3 | 13.2 |
| 300 | 9.6 | 4.8 | 2.4 | 12.4 | 10.7 | 8.0 | 16.0 | 14.9 | 12.3 |
| 400 | 7.0 | 3.2 | 2.6 | 13.5 | 9.0 | 8.9 | 18.4 | 16.4 | 14.8 |
| LSD | 1.7 | 0.9 | 0.6 | 2.5 | 1.2 | 0.8 | 5.4 | 2.7 | 1.8 |

Nitrogen had no effect on the content of soluble solids, titratable acid or anthocyanin in the fruits. The content of potassium in fruits, decreased from 3.0 g/kg to 2.5 g/kg with nitrogen supply increasing from 100 to 400 kg per/ha.

The content of soluble solids increased with planting distance and harvest time (Table 5). The content of titratable acids decreased with harvest time (Table 5). The content of anthocyanins (Table 5) increased with increasing planting distance and with a later harvest.

Table 3. Yield of kg umbels per bush at three planting distances in three years. Average of four levels of nitrogen and three harvest times.

Skærmudbytte, kg pr. busk, ved tre planteafstande i tre år. Gennemsnit for kvælstoftrin og høsttid.

| Year | Planting distance, m | | | LSD |
|------|----------------------|-------|-------|------|
| | 1 | 2 | 3 | |
| 1985 | 4.40 | 4.09 | 3.79 | 0.42 |
| 1986 | 5.33 | 8.29 | 10.92 | 0.62 |
| 1987 | 7.33 | 13.57 | 19.23 | 1.36 |

Table 5. Content of soluble solids, anthocyanins (as cyanidin-3-glucoside) and titratable acid (as citric acid) in fruits. Average of nitrogen levels, harvest time and over three years.

Indhold af opløseligt tørstof, farvestoffer (anthocyaniner) og titrerbar syre (beregnet som citronsyre) i frugter. Gennemsnit for kvælstoftrin, høsttider og år.

| Planting distance, m | Soluble solids w/w% | Anthocyanins mg/100 g | Titratable acid g/kg |
|----------------------|---------------------|-----------------------|----------------------|
| 1 | 9.1 | 616 | 9.8 |
| 2 | 9.7 | 710 | 10.3 |
| 3 | 9.9 | 796 | 10.2 |
| LSD | 0.5 | 77 | 0.6 |
| Days | | | |
| 1 | 8.9 | 478 | 12.1 |
| 7 | 9.8 | 711 | 9.8 |
| 14 | 10.0 | 934 | 8.4 |
| LSD | 0.5 | 77 | 0.6 |

Discussion

Because of difficulties of harvesting at 1 m planting distance after four years (1987) and the low anthocyanin content at this distance (Table 5) it is recommended to clear away 50 p.c. of the bushes after the fourth or fifth growing season.

As it was aimed to keep the plants as bushes the results may not be fully comparable to earlier experimental results (3).

From Table 4 it is obvious that a high plant density and a level of 300–400 kg N/ha can be recommended for elderberry orchards with grass strips. The row distance may be reduced to 4 m, depending on the machinery available. A planting distance of 1 m is recommended for the first three growing seasons. A further increase of bush yield is expected for the next 4–5 growing seasons.

The content of soluble solids, acids and potassium are in accordance with values mentioned in the literature (1, 2, 3, 5, 9).

During maturation and flavour development the content of soluble solids (Table 5) increased and the titratable acid content decreased (Table 5) as is normal for other fruits and berries.

To get a high content of anthocyanins the harvest be delayed as much as possible (Table 5) without reaching the over-ripe stage, causing an unsatisfactory flavour and fruit fall. As a general rule it should be about two weeks after a maturation stage corresponding to 90 p.c. black fruits in the umbels.

Levels of nitrogen supply had no effect on the content of soluble solids, titratable acid or an-

thocyanin in the fruits. These quality factors are mainly affected by the degree of maturation which is influenced by planting distance and, of course, harvest time.

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