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The relationship between root biomass and productivity of spring oilseed rape (*Brassica napus* L.) as influenced by crop density and fertilization

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Abstract

A field experiment was conducted from 2008 to 2010 at the Experimental Station of the Lithuanian University of Agriculture (currently – Aleksandras Stulginskis University) on a *Calc(ar)i-Endohypogleyic Luvisol* (*LVg-n-w-cc*). The objective of this study was to establish the relationship between root biomass and productivity of spring oilseed rape (*Brassica napus* L.) as influenced by crop density and fertilization level. Treatments of the experiment: factor A – fertilization: 1) without fertilizers, 2) with fertilizers ($N_{134}P_{64}K_{94}$); factor B – crop density: 1) 2 kg ha^{-1} (50.1–100 plants m^{-2}), 2) 4 kg ha^{-1} (100.1–150 plants m^{-2}), 3) 6 kg ha^{-1} (150.1–200 plants m^{-2}), 4) 8 kg ha^{-1} (200.1–250 plants m^{-2}), 5) 10 kg ha^{-1} (250.1–300 plants m^{-2}), 6) 12 kg ha^{-1} (300.1–350 plants m^{-2}), 7) 14 kg ha^{-1} (350.1–400 plants m^{-2}), 8) 16 kg ha^{-1} (400.1–450 plants m^{-2}).

It was established that without fertilizers, the highest root dry biomass (2.48 t ha^{-1}) of spring oilseed rape at the 0–10 cm soil layer was formed at a plant density of 150.1–200 plants m^{-2}, while in the crop with fertilizers at a plant density of 100.1–150 plants m^{-2} (2.64 t ha^{-1}). Plant root biomass in the 0–10 cm soil layer at a very high crop density (400–450 plants m^{-2}) with and without fertilizers was significantly ($P < 0.05$) lower (by 35.0% to 37.9% and by 32.2% to 40.9%, respectively) as compared with those densities, where root biomass was the highest. In the treatment without fertilizers parabolic statistically significant ($P < 0.05$) relationships were established between rape crop density and root dry biomass at the 0–10 and 10–20 cm soil layers. Mineral fertilization, compared with no fertilization, significantly ($P < 0.05$) increased (by 34.7% to 44.6%) spring rape root biomass at the 0–10 cm soil layer and did not have any significant effect on root biomass at the 10–20 cm soil layer. Parabolic and statistically significant ($P < 0.01$) relationships exist between the above-ground dry biomass of oilseed rape and plant density. In the crop without fertilizers, the highest spring rape seed yield (2.31–2.38 t ha^{-1}) was obtained at a crop density of 250.1–350 plants m^{-2} and in the crop with fertilizers – at a crop density of 100.1–200 plants m^{-2} (3.28–3.32 t ha^{-1}). A trend of spring oilseed yield decrease with increasing crop density at investigated levels of fertilization was established. Mineral fertilization, compared with no fertilization, at all spring rape plant densities significantly ($P < 0.05$) (from 30.3% to 81.4%) increased rape seed yield. In the crop without fertilizers, spring rape seed yield significantly depended on the crop density ($r^2 = 0.90$, $P < 0.05$) and the above-ground dry biomass of rape at the flowering stage ($r^2 = 0.67$, $P < 0.05$). In the crop with fertilizers, rape seed yield was significantly influenced by the crop density ($r^2 = 0.66$, $P < 0.05$) and dry biomass of rape roots in the 0–10 cm soil layer at the flowering stage ($r^2 = 0.86$, $P < 0.01$).

Key words: above-ground dry biomass, *Brassica napus*, crop density, fertilization, root biomass, seed yield.

Introduction

Roots are important for anchorage to the plant and supply of water and nutrients (Mandal et al., 2010). Due to this fact, root growth and development are highly plastic (Neumann, Martinoia, 2002). Under many climatic conditions, the root system does not appear to limit crop growth or yield and is more than adequate for maintaining the supply of nutrients and water of the shoot. Reductions in the rate of uptake of soil resources such as water and nitrogen lead to changes in assimilate allocation, which can increase the size of the root system (Hoad et al., 2001). Activity of plant root system depends on the supply of nutrients and carbohydrates. Active growth of root system affects intensity of photosynthesis and yield of plants (Lapins et al., 2011).

Growth and biomass of oilseed rape roots depend on the climatic factors (Kjellström, Kirchmann, 1994), soil properties (Barraclough, 1989; Trükmann et al., 2008), cultivar (Kamh et al., 2005), crop density (Liakas et al., 2006), fertilization (Dreccer et al., 2000; Kamh et al., 2005; Govahi, Saffari, 2006), water and cultivation technology (Mandal et al., 2010). The growth and dry matter accumulation of roots of different annual crops also vary significantly. Oilseed rape had similar or lower root biomass than wheat, depending on nitrogen level, but higher root length per unit soil volume and specific root length (Dreccer et al., 2000). Pietola and Alakukku (2005) found that the average total dry biomass of spring oilseed rape (110 g DM m^{-3}) root was less than that of barley (160 g DM m^{-3}), oats (260 g DM m^{-3}) and ryegrass (340 g DM m^{-3}). Most of the root biomass was accumulated in the upper 20 cm soil layer. Mineral nutrients supply greatly affects both size and morphology of root systems and among nutrients nitrogen (Durieux et al., 1994), and phosphorus (Kuang et al., 2005) are said to have greater influence on root growth, while potassium effect is not well documented (Robinson, Vuuren, 1998). According to Iman et al. (2006) fertility levels significantly influenced root weight of crops, while cropping systems did not affect root biomass. Hundred and fifty percent of the recommended fertility level recorded heaviest root dry weight of crops, 50% of recommended rate resulted in least root dry weight, while the medium fertility level recorded average root dry weight. Gersani and Sachs (1992) also reported that mineral fertilizers increased the root biomass of oilseed rape. Root and shoot ratio is important for plant survival especially under drought conditions (Kimiti, 2011). Kimiti (2011) found strong positive and significant correlations between root and shoot biomass of crops. Lapins et al. (2011) estimated that root mass of plants was the most significant parameter which determined formation of oilseed rape yield. According to Blake et al. (2006), a significant relationship existed between crop biomass and yield. Results of Lapins et al. (2011) showed that root biomass of oilseed rape plants positively correlated with rape above-ground biomass. However, all of these studies focused only on one index of rape productivity, and did not examine the relationships between root biomass, above-ground dry biomass and seed yield of spring oilseed rape under different crop densities and fertilization.

The objective of this study was to establish the relationship between root biomass and productivity of spring oilseed rape as influenced by crop density and fertilization.

Materials and methods

A field experiment was conducted from 2008 to 2010 at the Experimental Station of Lithuanian University of Agriculture (54°53′ N, 23°50′ E). The soil of the experimental site is *Calc(ar)i-Endohypogleyic Luvisol* (*LVg-n-w-cc*), and its texture – medium clay loam on heavy clay loam. Soil exchange acidity was 6.97 pH, content of humus 2.51%, available P_2O_5 and K_2O 242 and 124 mg kg^{-1}, respectively. Treatments of the experiment: factor A – fertilization: 1) without fertilizers, 2) with fertilizers ($N_{134}P_{64}K_{94}$); factor B – crop density: 1) 2 kg ha^{-1} (50.1–100 plants m^{-2}), 2) 4 kg ha^{-1} (100.1–150 plants m^{-2}), 3) 6 kg ha^{-1} (150.1–200 plants m^{-2}), 4) 8 kg ha^{-1} (200.1–250 plants m^{-2}), 5) 10 kg ha^{-1} (250.1–300 plants m^{-2}), 6) 12 kg ha^{-1} (300.1–350 plants m^{-2}), 7) 14 kg ha^{-1} (350.1–400 plants m^{-2}), 8) 16 kg ha^{-1} (400.1–450 plants m^{-2}).

Different crop densities of spring oilseed rape (*Brassica napus* L. ssp. *oleifera annua* Metzg) were formed by a precision seed-drill with respect to rape cv. 'Sponsor' seed germination rate and 1000 seed weight. Size of sampling plot was 27.0 m^2, number of replications – 3. A randomized replication block design was applied. Soil tillage: in the autumn conventional ploughing at the depth of 23–25 cm, in spring – cultivation (twice) and harrowing. Pre-crop – bare fallow. Rape was sprayed twice against pests with lambdacihalotrin (0.0075 kg ha^{-1}). Fertilization: before rape sowing 64 kg ha^{-1} N, 64 kg ha^{-1} P_2O_5, 94 kg ha^{-1} K_2O (400 kg ha^{-1} azophoska and 50 kg ha^{-1} potassium chloride) and at the budding stage 70 kg ha^{-1} N (200 kg ha^{-1} ammonium nitrate).

The agrochemical characteristics of the soil were determined as follows: pH_{KCl} was measured potentiometrically, content of humus according to Tiurin, mobile nutrients with a infrared spectrometer PSCO/ISI IBM-PC 4250 ("Pacific Scientific", USA) and a calibration curve. Roots were studied in each plot at the 0–10 and 10–20 cm soil depth using the small monolith (0.001 m^3) method at spring rape flowering stage (Lapinskienė, 1993). Crop density of spring rape was determined in four places of each field by counting plants within a 0.25 m^2 frame. In order to determine the above-ground dry biomass of rape at the flowering stage, ten plants were taken from each experimental plot. Plants were weighed and dried for 24 h in a thermostat at 105°C. The yield of dry biomass of the plants was expressed in t ha^{-1}.

LSD Fisher protected test, paired regression and correlation analyses for the statistical data estimation were applied. Significant interaction between factors A and B was established, therefore the results of factors' main effects were not presented in the paper. The interaction between investigated factors and vegetation seasons (years) was not significant and the data averaged over years were presented. The data of rape root biomass, that did not meet the normal distribution, were transformed by using the function $y = lnx$ before statistical evaluation (Tarakanovas, Raudonius, 2003).

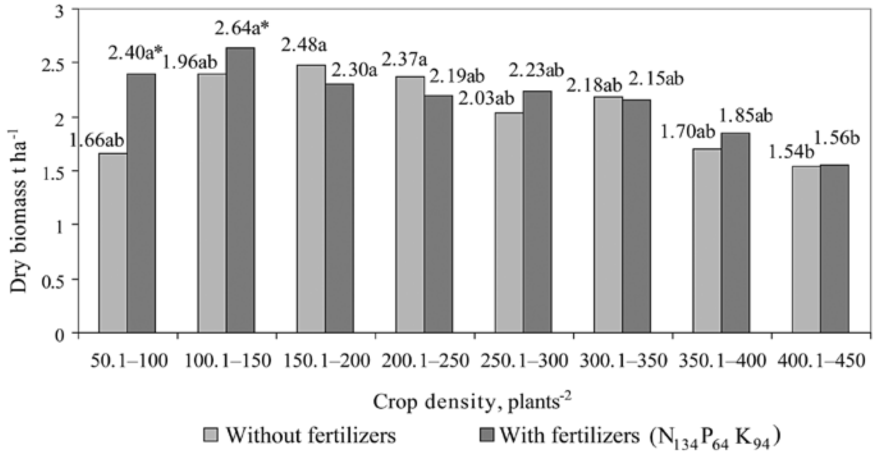
Meteorological conditions. In 2008, the sum of active temperatures (≥10°C) within the period of plant growth was 1808.5°C, the level of rainfall was 231.0 mm and the hydrothermal coefficient (HTC) was 1.28. In 2009, the sum of active temperatures within the period of plant growth was 1630.5°C, the level of rainfall was 240.9 mm and the HTC was 1.48. In 2010, the sum of active temperatures within the period of plant growth was 1762.7°C, the level of rainfall was 352.1 mm and the HTC was 2.00. HTC was calculated using the formula of Selianinov (Dirsė, 2001):

$HTC = \Sigma p \times (0.1 \times \Sigma t)^{-1}$, where Σp – total rainfall mm during the rape vegetation period, Σt – sum of air temperatures ≥10°C during the same period.

Results and discussion

Dry biomass of spring oilseed rape root. Based on the obtained data in all experimental years it is evident that the dry biomass of spring oilseed rape root was affected by crop density, fertilization level and soil layer. The highest dry biomass of spring rape root was accumulated at the 0–10 cm soil layer (Fig. 1). The root biomass at the 10–20 cm soil layer was found to be by 4.0 to 7.8 times lower than that at the 0–10 cm soil layer. Barraclough (1989) reported that most rape root growth occurred in the top 20 cm of soil; between 66% and 80% of the total root length was there.

In the crop without fertilizers, the highest root biomass (2.48 t ha^{-1}) at the 0–10 cm soil layer was formed at a crop density of 150.1–200 plants m^{-2} (Fig. 1). With the increasing spring rape crop density from 200.1 to 400 plants m^{-2} the root biomass decreased; however, no significant differences were established. At a crop density of 400.1–450 plants m^{-2} the decrease of root biomass was significant (by 35.0% to 37.9%), compared with the crop density of 150.1–250 plants m^{-2}. In the crop with fertilizers, the highest root biomass (2.64 t ha^{-1}) at the 0–10 cm soil layer was obtained at a crop density of 100.1–150 plants m^{-2}. With the increasing spring rape crop density from 150.1 to 400 plants m^{-2} the root biomass decreased; however, no significant differences were established. At a crop density of more than 400.1 plants m^{-2} the decrease of root biomass was significant (by 32.2% to 40.9%), compared with the crop density of 50.1–200 plants m^{-2}. This suggests that roots of oilseed rape plants at high crop density were much smaller as compared with those at low density. In the spring oilseed crop with and without fertilizers the highest rape root dry biomass (0.48 and 0.56 t ha^{-1}) in the 10–20 cm soil layer was formed at the plant density of 250.1–300 plants m^{-2}. With the increasing crop density from 300.1 to 450 plants m^{-2} the root dry biomass of rape in the 10–20 cm soil layer decreased; however, no significant differences were established at investigated levels of fertilization. Liakas et al. (2006) reported that with increasing rape crop density the root biomass decreased as well.

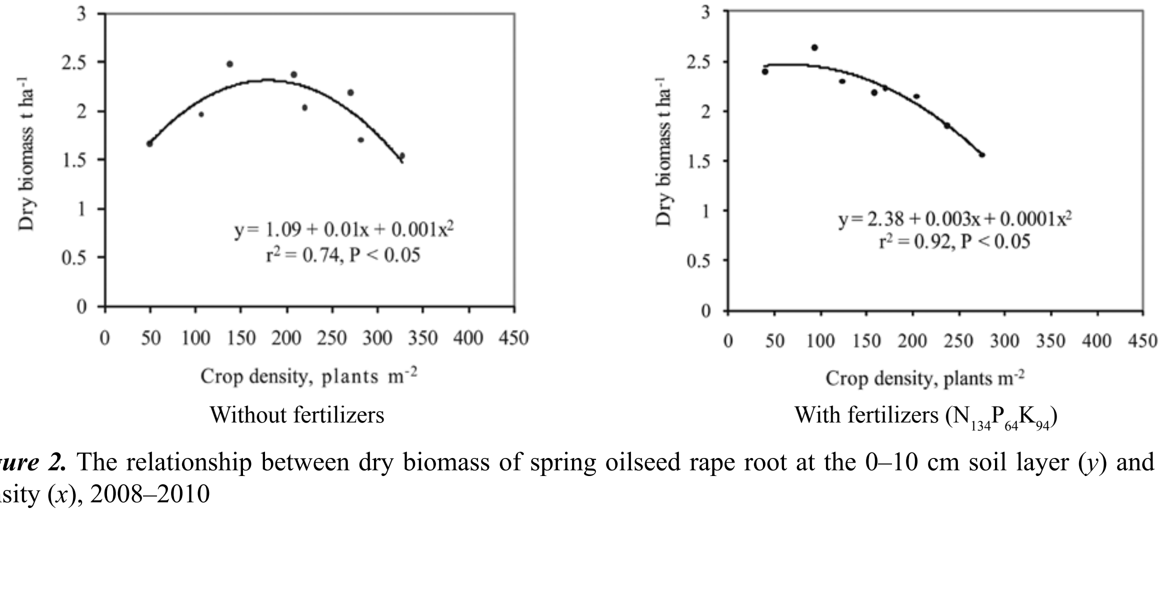


Note. * – means of factor A are significantly ($P < 0.05$) different at each density level of spring oilseed rape; means of factor B not sharing common letters (a, b) are significantly different ($P < 0.05$).

Figure 1. Dry biomass of spring oilseed rape root at the 0–10 cm soil layer at the flowering stage as influenced by fertilization (factor A) and crop density (factor B), 2008–2010

Parabolic and statistically significant relationships were established between spring rape crop density and root dry biomass at the 0–10 cm soil layer (Fig. 2). In the crop without fertilizers, parabolic and statistically significant relationship exists between spring rape crop density and root dry biomass in the 10–20 cm soil layer ($y = 0.34 + 0.001x + 0.0001x^2$; $r^2 = 0.79$, $P < 0.05$).

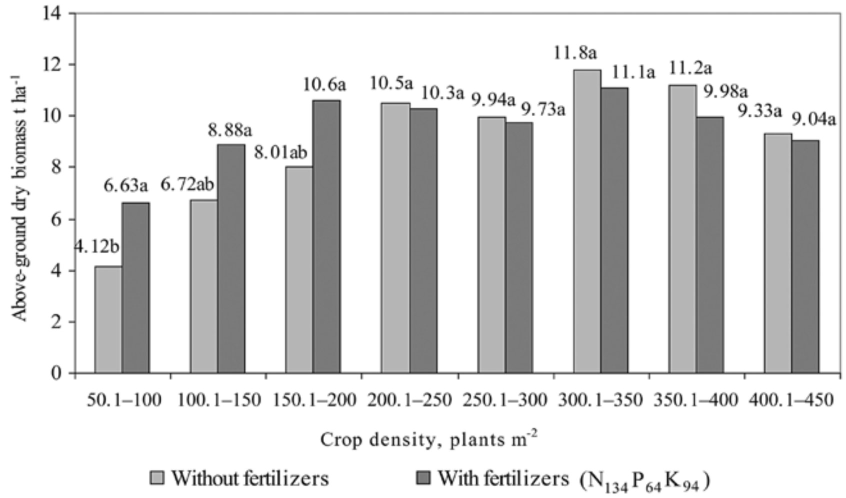
According to our data, mineral fertilization, compared with no fertilization, significantly increased (by 34.7% to 44.6%) root biomass of rape at the 0–10 cm soil layer only in the lower crop densities (50.1–150 plants m^{-2}). The trend was established showing that at lower crop densities root biomass in the 10–20 cm soil layer was less when mineral fertilizers were applied. This suggests that plant roots developed more intensively in the upper soil layer when fertilizers had been applied and roots had to penetrate deeper for nutrients when fertilization had not been used. Controlling the level of nutrient supply of plants is one of the factors that condition the rate of the formation and reduction of vegetative organs (Colnenne et al., 2002). Han et al. (2010) established that mineral fertilizers increased the root biomass of oilseed rape. According to Kamh et al. (2005) at the flowering stage, higher root production of rape and accordingly higher nitrogen depletion was observed at N_0 compared to N_{227}. Zhang et al. (2010) reported that under low nitrogen supply conditions, high nitrogen efficiency oilseed rape cultivars had longer roots and more lateral roots.



Without fertilizers

With fertilizers ($N_{134}P_{64}K_{94}$)

Figure 2. The relationship between dry biomass of spring oilseed rape root at the 0–10 cm soil layer (y) and crop density (x), 2008–2010



Note. Means of factor B not sharing common letters (a, b) are significantly different ($P < 0.05$).

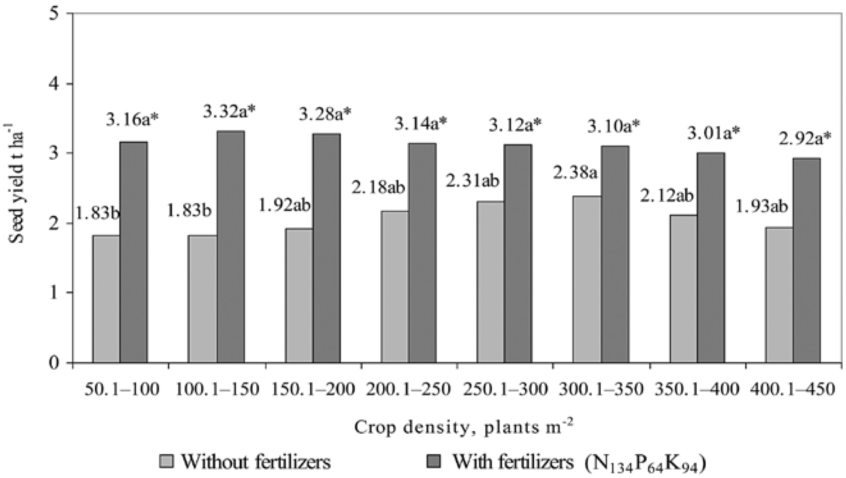
Figure 3. Yield of the above-ground dry biomass of spring oilseed rape at the flowering stage as influenced by fertilization (factor A) and crop density (factor B), 2008–2010

Above-ground dry biomass of spring oilseed rape. In the crop without fertilizers, with increasing spring rape crop density up to 200 plants m^{-2}, compared with the lowest density, the above-ground dry biomass of rape increased (Fig. 3). However, no significant differences were established. At a crop density of 200.1–450 plants m^{-2} the increase of above-ground dry biomass of rape was significant (from 2.3 to 2.9 times), compared with the lowest crop density. Crop density had no significant effect on the above-ground dry biomass of rape in the crop with fertilizers. Other researchers found that with increasing crop density the above-ground dry biomass of rape per unit area increased (Al-Barzinjy et al., 2003; Kazemeini et al., 2010).

The data of our studies showed that fertilization did not have significant influence on the above-ground dry biomass of rape in comparison without fertilization. According to Kazemeini et al. (2010) mineral fertilization, compared with no fertilization, significantly increased the above-ground dry biomass of rape.

The statistical analysis of the data indicated parabolic and statistically significant relationships between the above-ground dry biomass of oilseed rape and plant density (without fertilizers – $y = 0.11 + 0.08x + 0.001x^2$; $r^2 = 0.94$, $P < 0.01$, with fertilizers – $y = 4.28 + 0.07x + 0.001x^2$; $r^2 = 0.88$, $P < 0.01$).

Seed yield of spring oilseed rape. According to our data, the least seed yield (1.83 t ha^{-1}) of spring rape was determined at the lowest plant density (50.1–100 plants m^{-2}) without fertilizers (Fig. 4). With increasing spring rape crop density from 100.1 to 300 plants m^{-2} the seed yield increased; however, no significant differences were established. At a crop density of 300.1–350 plants m^{-2} the increase of rape seed yield was significant (by 30.1%) in comparison with the lowest crop density. At a crop density of more than 350.1 plants m^{-2} a decrease of rape seed yield was established. At high crop density the intraspecific competition is more evident and plant productivity is usually lower. In the crop with fertilizers the highest rape seed yield (3.32 t ha^{-1}), compared with the lowest density, was determined at a crop density of 100.1–150 plants m^{-2}; however, no significant differences were established. According to Diepenbrock (2000), pant density has the greatest effect on rape seed yield and the yield components of individual plants.



Note. * – means of factor A are significantly ($P < 0.05$) different at each density level of spring oilseed rape; means of factor B not sharing common letters (a, b) are significantly different ($P < 0.05$).

Figure 4. Seed yield of spring oilseed rape as influenced by fertilization (factor A) and crop density (factor B), 2008–2010

Mineral fertilization, compared with not fertilized crops, significantly increased (from 30.3% to 81.4%) the rape seed yield. Many authors have indicated that mineral fertilizers increased the seed yield of oilseed rape (Dreccer et al., 2000; Новицкая, 2008; Kazemeini et al., 2010). Šidlauskas and Bernotas (2003) have reported that the seed yield of spring oilseed rape was significantly affected by nitrogen rates of up to 120 kg ha^{-1}. Further increase in nitrogen fertilization had only a little effect on the seed yield. According to Šiaudinis and Lazauskas (2009), in the year unfavourable for spring rape growing the highest nitrogen efficiency was obtained by applying 150 kg ha^{-1} nitrogen rate.

In the crop without fertilizers, spring rape seed yield depended on the crop density ($y = 2.17 - 0.01x + 0.001x^2 + 0.001x^3$; $r^2 = 0.90$, $P < 0.05$) and the above-ground dry biomass of rape at the flowering stage ($y = 1.44 + 0.07x$; $r^2 = 0.67$, $P < 0.05$). In the crop with fertilizers, rape seed yield was influenced by crop density ($y = 3.35 - 0.001x$; $r^2 = -0.66$, $P < 0.05$) and dry biomass of rape root in 0–10 cm soil layer at the flowering stage ($y = 2.34 + 0.37x$; $r^2 = 0.86$, $P < 0.01$).

Conclusions

1. In the treatment without fertilizers, the highest root dry biomass (2.48 t ha^{-1}) of spring oilseed rape at the 0–10 cm soil layer was formed at a plant density of 150.1–200 plants m^{-2}, while in the crop with fertilizers at a plant density of 100.1–150 plants m^{-2} (2.64 t ha^{-1}). Plant root biomass at the 0–10 cm soil layer at a very high crop density (400–450 plants m^{-2}) with and without fertilizers was significantly ($P < 0.05$) lower (35.0–37.9% and 32.2–40.9%, respectively) as compared with those densities, where root biomass was the highest. In the crop without fertilizers, parabolic and statistically significant ($P < 0.05$) relationships were established between rape crop density and root dry biomass at the 0–10 and 10–20 cm soil layers.

2. Mineral fertilization, compared with no fertilization, significantly ($P < 0.05$) increased (from 34.7% to 44.6%) spring rape root biomass at the 0–10 cm soil layer and did not have any significant effect on root biomass at the 10–20 cm soil layer.

3. Parabolic and statistically significant ($P < 0.01$) relationships were established between the above-ground dry biomass of oilseed rape and plant density.

4. In the crop without fertilizers the highest spring rape seed yield (2.31–2.38 t ha^{-1}) was obtained at a crop density of 250.1–350 plants m^{-2} and in the crop with fertilizers – at a crop density of 100.1–200 plants m^{-2} (3.28–3.32 t ha^{-1}). The trend of spring oilseed yield decrease with increasing crop density at investigated levels of fertilization was determined. Mineral fertilization, compared with no fertilization, at all spring rape plant densities significantly ($P < 0.05$) (from 30.3 to 81.4%) increased rape seed yield.

5. In the crop without fertilizers, spring rape seed yield significantly depended on the crop density ($r^2 = 0.90$, $P < 0.05$) and the above-ground dry biomass of rape at the flowering stage ($r^2 = 0.67$, $P < 0.05$). In the crop with fertilizers, rape seed yield was significantly influenced by the crop density ($r^2 = 0.66$, $P < 0.05$) and dry biomass of rape root at the 0–10 cm soil layer at the flowering stage ($r^2 = 0.86$, $P < 0.01$).

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Vasarinio rapso (*Brassica napus* L.) šaknų biomasės ir produktyvumo ryšys, priklausomai nuo pasėlio tankumo bei tręšimo

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Santrauka

Lauko bandymas vykdytas 2008–2010 m. Lietuvos žemės ūkio universiteto (dabar – Aleksandro Stulginskio universitetas) Bandymų stotyje, karbonatingame giliau glėjiškame išplautžemyje (IDg4-k). Tyrimų tikslas – nustatyti vasarinio rapso (*Brassica napus* L.) šaknų biomasės ir produktyvumo ryšį, priklausomai nuo pasėlio tankumo bei tręšimo. Variantai: A veiksnys – tręšimas: 1) netręšta, 2) tręšta ($N_{134}P_{64}K_{94}$); B veiksnys – pasėlio tankumas: 1) 2 kg ha^{-1} (50,1–100 augalų m^{-2}), 2) 4 kg ha^{-1} (100,1–150 augalų m^{-2}), 3) 6 kg ha^{-1} (150,1–200 augalų m^{-2}), 4) 8 kg ha^{-1} (200,1–250 augalų m^{-2}), 5) 10 kg ha^{-1} (250,1–300 augalų m^{-2}), 6) 12 kg ha^{-1} (300,1–350 augalų m^{-2}), 7) 14 kg ha^{-1} (350,1–400 augalų m^{-2}), 8) 16 kg ha^{-1} (400,1–450 augalų m^{-2}).
Nustatyta, kad didžiausia vasarinių rapsų šaknų masė (2,48 t ha^{-1}) dirvožemio 0–10 cm sluoksnyje netręšiant formavosi 150,1–200 augalų m^{-2}, tręšiant – 100,1–150 augalų m^{-2} tankumo pasėlyje (2,64 t ha^{-1}). Ir netręštame, ir tręštame tankiausiame (400–450 vnt. m^{-2}) rapsų pasėlyje augalų šaknų masė dirvožemio 0–10 cm sluoksnyje nustatyta esmingai (P < 0,05) mažesnė (35,0–37,9 ir 32,2–40,9 %), lyginant su pasėliais, kurių šaknų masė buvo didžiausia. Netręštuose rapsuose tarp pasėlio tankumo ir augalų šaknų masės dirvožemio 0–10 bei 10–20 cm sluoksniuose nustatyti paraboliniai ir esminiai (P < 0,05) priklausomybės ryšiai. Tręšimas mineralinėmis trąšomis, lyginant su netręštais rapsais, jų šaknų masę esmingai (P < 0,05) didino (nuo 34,7 iki 44,6 %) dirvožemio 0–10 cm sluoksnyje, o 10–20 cm sluoksnyje esminės įtakos neturėjo. Tarp rapsų pasėlio tankumo ir vasarinių rapsų antžeminės masės žydėjimo tarpsniu nustatyti paraboliniai ir esminiai (P < 0,01) priklausomybės ryšiai. Rapsų netręšiant mineralinėmis trąšomis, didžiausias sėklų derlius (2,31–2,38 t ha^{-1}) nustatytas 250,1–350 augalų m^{-2}, tręšiant – 100,1–200 augalų m^{-2} tankumo pasėlyje (3,28–3,32 t ha^{-1}). Rapsų pasėliui tankėjant abiejuose tręšimo fonuose nustatyta sėklų derliaus mažėjimo tendencija. Tręšimas mineralinėmis trąšomis, lyginant su netręštais rapsais, sėklų derlių esmingai (P < 0,05) didino (nuo 30,3 iki 81,4 %). Rapsų netręšiant, sėklų derlius priklausė nuo pasėlio tankumo (r^2 = 0.90, P < 0.05) ir augalų antžeminės masės žydėjimo tarpsniu (r^2 = 0.67, P < 0,05). Rapsus tręšiant mineralinėmis trąšomis, sėklų derliui turėjo įtakos pasėlio tankumas (r^2 = 0.66, P < 0,05) ir šaknų masė dirvožemio 0–10 cm sluoksnyje žydėjimo tarpsniu (r^2 = 0.86, P < 0,01).

Reikšminiai žodžiai: antžeminė masė, *Brassica napus*, pasėlio tankumas, sėklų derlius, šaknų masė, tręšimas.