

EVALUATION OF COMPARATIVE PRODUCTIVITY OF THE ROMANIAN PEA VARIETY 'NICOLETA' UNDER CONVENTIONAL AND NO-TILL SYSTEMS IN THE ARID REGION OF DOBROGEA

STROE TRAIAN CIPRIAN^{1*}, MIRON LILIANA AND PANAITESCU LILIANA¹

Ovidius University of Constanta, University Alley, Campus building B, Constanta, Romania

Keywords: Pea productivity, Nicoleta variety, Conventional system, No-till system, Arid climate

Abstract

This study evaluated the agronomic performance of the Romanian pea variety “Nicoleta” (*Pisum sativum* L.) under two soil tillage systems: conventional and no-till during 2021-2024, in the pedoclimatic conditions of Săcele, Constanța County. The effects of tillage on vegetative growth, reproductive traits, yield, and their relationships with climatic factors were analyzed. Conventional tillage resulted in taller plants, slightly more pods per plant, and a higher thousand seed weight (TSW), and these differences were statistically significant according to ANOVA. Although conventional tillage produced higher yields, the no-till system ensured stable and competitive productivity, particularly in low-rainfall years, due to controlled irrigation. Regression analyses showed a strong positive correlation between TSW and yield, and a moderate relationship between pods per plant and productivity. Rainfall had limited influence because irrigation compensated for water deficits. Overall, the “Nicoleta” variety proved adaptable and productive, and the no-till system represents a viable, sustainable option for modern, resource-efficient agriculture.

Introduction

In a global context marked by climate change, declining water resources, and soil degradation, modern agriculture is increasingly required to adopt sustainable practices that maintain productivity while conserving natural resources. Reduced tillage systems, particularly no-till, are gaining importance in vulnerable agricultural regions such as southeastern Romania. Pea (*Pisum sativum* L.), a legume of high agronomic and nutritional value, is suitable for crop rotations due to its protein content, nitrogen fixation, and soil-improving capacity (Drew *et al.* 2007). Adaptable to medium-fertility soils and various technological systems, pea also fits well within conservation agriculture (Janusauskaite 2023).

In Romania, as in other European regions, the shift toward reduced soil disturbance is driven by ecological and economic factors. Intensive tillage may lead to soil structure degradation, humus loss, and reduced water retention (Panaitescu 2016), whereas no-till systems help preserve structure, reduce erosion, and enhance biodiversity (Boincean *et al.* 2020, Stroe and Panaitescu 2025). Previous studies on pea have shown variable responses to tillage, depending on pedoclimatic conditions, variety, and inputs. While there are some report advantages of conventional tillage in early growth and weed control (Santín-Montanyá *et al.* 2014, Woźniak and Rachoń 2019, Mihaș *et al.* 2023), others highlight the economic and environmental benefits of no-till, especially in drought-prone areas (Zhao *et al.* 2019, Macák *et al.* 2020). Varietal adaptability is also essential, as the genetic background and physiological plasticity of pea cultivars strongly influence their response to environmental and technological factors (Schroeder *et al.* 1993). The Romanian pea variety “Nicoleta” shows tolerance to water stress and has a semi-leafless structure favorable for harvesting (Șimon *et al.* 2017), with productivity strongly influenced by

*Author for correspondence: <str_ciprian@yahoo.com>. ¹University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăști Blvd, District 1, Bucharest, Romania.

water availability from rainfall or irrigation (Payne *et al.* 2000, Okçu *et al.* 2005). Fertilization and crop rotation further affect yields, with rational nutrient management improving productivity and nodule activity (Drew *et al.* 2007, Adela *et al.* 2010, Macák *et al.* 2020).

This study evaluates the effects of conventional and no-till tillage on the vegetative development and yield of the “Nicoleta” variety under the pedoclimatic conditions of Săcele, Constanța County. The analysis reflects regional needs for reduced energy inputs and improved adaptation to increasingly variable climate conditions in Dobrogea

Materials and Methods

This research was carried out over three agricultural years (2021-2024) at SC NATURALIA SRL, Săcele, Constanța County, Romania. The field experiment followed a randomized block design with two technological variants: (1) conventional tillage, consisting of autumn plowing (20 cm) followed by spring disking and harrowing, and (2) no-till, where sowing was performed directly into crop residues without prior soil disturbance. All other technological inputs: fertilization, weed control, irrigation, and harvesting, were identical in both systems. The “Nicoleta” variety, semi-leafless and lodging-resistant, was sown annually between February 25 and March 05 at a density of 100 plants/m² and 4 cm depth. Fertilization consisted of 80 kg N/ha applied in split doses. Due to weak nodule formation, seed inoculation with *Rhizobium leguminosarum* (Nitragin type) was introduced starting in 2022. For each variant, biometric measurements were taken on 20 plants per plot, including plant height, pods per plant, seeds per pod, pod weight, thousand-seed weight (TSW), and yield (kg/ha). Data were recorded annually and combined into a unified dataset.

Statistical analysis used ANOVA at $p < 0.05$ to evaluate treatment effects. Significant differences were further analyzed using the LSD test. Multiple linear regression models were applied to assess relationships between yield and plant height, pods per plant, and TSW, with model validity evaluated through R^2 and p-values.

The study period was characterized by variable pedoclimatic conditions, with a severe water deficit in 2023-2024 and moderate rainfall in earlier years. Mean annual temperatures averaged 11.3°C, while precipitation ranged from 295 to 420 mm. The soil is a medium-fertility cambic chernozem with good drainage and loamy texture. Irrigation consisted of four applications of 30 mm per season, applied equally in both systems. Harvesting took place mechanically between July 1-5 each year. The methodology ensured a robust comparison of the two tillage systems and supported the development of practical recommendations for pea cultivation in Dobrogea and similar regions.

Results and Discussion

The agricultural area of Săcele, in northeastern Constanța County belongs to the Central Dobrogea region and is characterized by a temperate-continental climate with Pontic influences. Proximity to Lake Sinoe and the Black Sea generates hot summers, mild winters, and low annual precipitation (300-400 mm), placing Dobrogea among Romania’s driest regions. Between 2021 and 2024, repeated rainfall deficits affected crop development, especially without irrigation.

Climatic variability during 2021-2024 is summarized in Fig. 1, showing marked differences in rainfall and temperature: 2022 was the most favorable (420 mm; 11.2°C), while 2024 was extremely dry (295 mm; 11.5°C). Year 2023 combined low rainfall (310 mm) with below-average temperatures (10.7°C). Despite these fluctuations, uniform irrigation largely compensated for rainfall deficits, resulting in a weak yield-precipitation correlation ($r = 0.16$). This indicates that the tillage system had a stronger influence on productivity than climatic variability alone.

A key indicator of the vegetative status of the pea crop is plant height at full flowering (BBCH 65), which reflects both root capacity to access soil resources and the influence of cultivation technology, particularly soil tillage. Experimental results showed consistent differences between the two systems: plants in the conventional variant reached an average height of 85.05 cm, compared with 77.99 cm under no-till. ANOVA confirmed the statistical significance of this difference ($p = 0.0016$; $F = 29.57$). Fig. 2 illustrates these results, highlighting not only higher mean values in the conventional system but also greater uniformity, indicated by a smaller standard deviation. The reduced height observed under no-till can be attributed to system-specific physiological and soil-related factors, including slower nitrogen mineralization, a denser upper soil layer, and lower aeration, all of which influence growth dynamics (Małecka-Jankowiak *et al.* 2016). However, despite the more compact soil conditions, no detrimental effects such as stunting or floral abortion were observed. The “Nicoleta” variety maintained adequate vegetative growth under no-till, supporting its suitability for conservation systems in the dry conditions of Dobrogea.

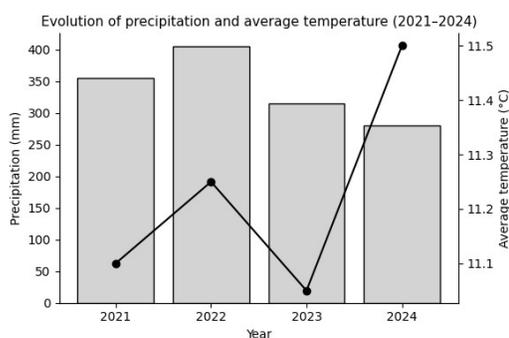


Fig 1. Annual precipitation (mm) and average temperature recorded at the experimental site during 2021-2024.

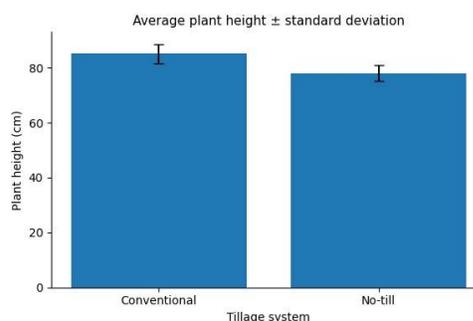


Fig. 2. Average plant height (cm) under conventional and no-till systems (mean \pm SD).

Reproductive parameters offer essential information on the crop's fruiting capacity and efficiency of biomass formation. In this study, two key indicators were evaluated: the average number of pods per plant and the thousand seed weight (TSW), both influenced by the tillage system. The conventional variant produced slightly more pods (10.4 pods/plant) than the no-till system (9.8 pods/plant), a difference confirmed as statistically significant by ANOVA ($p = 0.0099$). Differences in TSW followed a similar pattern: plants under conventional tillage reached an average of 245.3 g, compared with 235.4 g in the no-till variant. Although lower, the TSW obtained under no-till remains agronomically favorable given the technological and pedoclimatic conditions (Neugschwandtner *et al.* 2020). Fig. 3 illustrates these differences, showing higher and more uniform values under conventional tillage, while the no-till system still maintained results within an acceptable agronomic range.

The thousand seed weight (TSW) showed a strong positive correlation with total yield ($r = 0.72$), as illustrated in Fig. 4, confirming that individual seed weight is a direct indicator of plant physiological efficiency. The regression line demonstrates that higher TSW values are consistently associated with increased yields, regardless of tillage system. Maintaining a TSW above 230 g in the no-till variant supports its viability as an agronomic option, particularly in the context of conservation-oriented practices. Although TSW values were slightly lower under no-till, the system proved adaptable to restrictive soil and climatic conditions and provided stable production

levels. These findings highlight TSW as a key performance predictor and reinforce the potential of no-till as a sustainable solution in semi-arid environments.

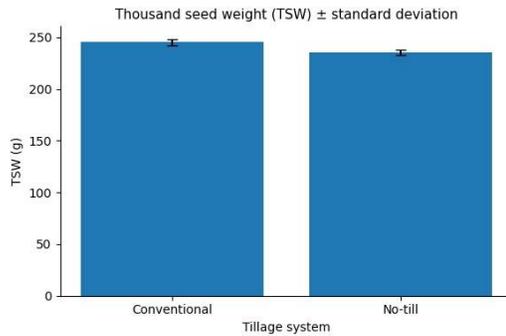


Fig. 3. Thousand seed weight (TSW) by tillage system \pm standard deviation.

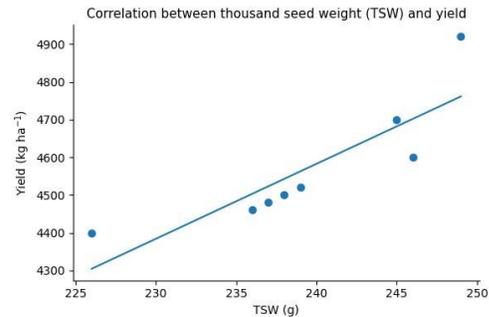


Fig. 4. Correlation between thousand seed weight (TSW) and yield (kg/ha).

Average yield per hectare is the main indicator of technological efficiency. Across the 2021-2024 experiment, consistent differences were recorded between the two tillage systems. The conventional variant achieved an average yield of 4817 kg/ha, while the no-till system produced 4556 kg/ha, resulting in a difference of approximately 261 kg/ha. Yield variability was also lower under conventional tillage, indicating a more uniform crop response compared with the no-till system (Fig. 5).

To reinforce these results, a simple linear regression model was applied, using tillage system as a binary predictor (0 = no-till, 1 = conventional). The model confirmed the significant effect of tillage ($p = 0.016$), with a positive coefficient of +260.8 kg/ha for the conventional system. Fig. 6 illustrates this relationship: conventional tillage points cluster at higher yield levels, while no-till values are slightly lower but display greater stability. Overall, although conventional tillage achieves the highest yields, the relatively narrow yield range between systems suggests that productivity results from multiple interacting factors: technology, climate, and plant physiology. Thus, no-till remains a viable and sustainable alternative within conservation-oriented agriculture.

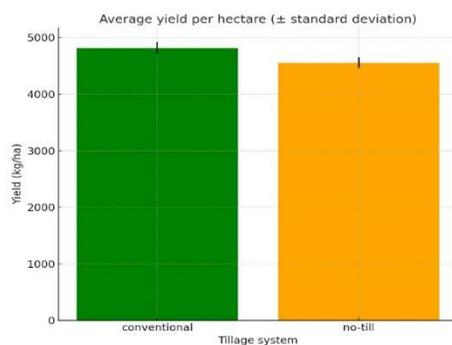


Fig. 5. Average yield per hectare (kg/ha)

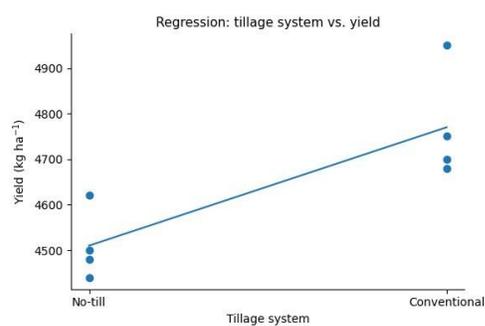


Fig. 6. Regression: tillage system vs. yield

ANOVA analysis confirmed that the yield differences between the two systems were statistically significant ($p = 0.016$), indicating a clear effect of tillage on productivity. The Tukey

HSD post-hoc test further supported this result, showing a significant separation between the two variants, with a confidence interval between -454 and -67 kg/ha, without overlap of the means. Although statistically significant, the yield gap is not large enough to undermine the technological viability of no-till. The yields obtained under this system remain high and competitive, demonstrating that, with proper management: irrigation, cultivar choice, and weed control, no-till can perform reliably under Dobrogea conditions.

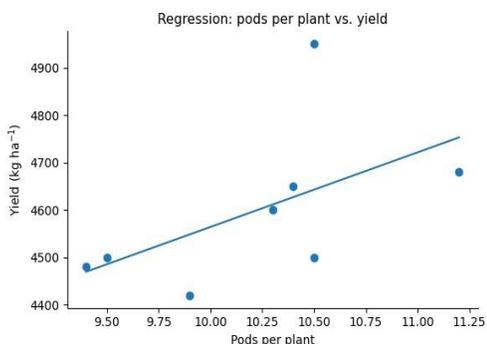


Fig. 7. Relationship between the number of pods per plant and seed yield in pea under different tillage systems.

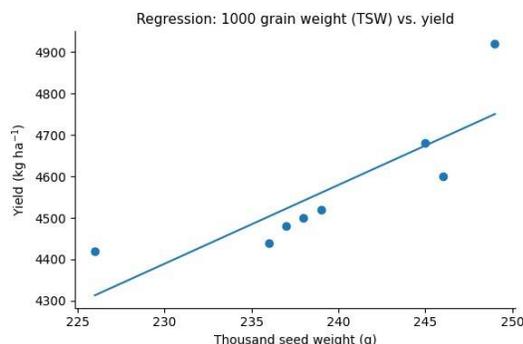


Fig. 8. Regression: 1000 grain weight (TSW) vs. Yield.

Regression analysis identified a moderately positive correlation between the number of pods per plant and yield ($r = 0.58$), with a statistically significant model ($p < 0.05$). This linear relationship indicates that increases in pod number contribute directly to higher biomass accumulation and, consequently, to improved yield, a pattern illustrated in Fig. 8. The correlation between TSW and yield was even stronger ($r = 0.72$), also statistically significant, confirming that seed weight is one of the most influential factors determining final output. Even when pod number was not maximized, plants producing heavier seeds contributed substantially to overall productivity. These findings reinforce TSW as a reliable indicator of physiological efficiency and a potential indirect selection criterion for evaluating crop performance under conservation tillage systems.

Contrary to expectations, regression analysis showed no significant relationship between annual precipitation and yield ($p = 0.70$), with a very low correlation coefficient ($r \approx 0.16$). As illustrated in Fig. 9, this weak association is mainly due to the four controlled irrigations applied each year, which substantially reduced crop dependence on natural rainfall.

Under supplemental irrigation, precipitation had only a minimal effect on final yield, even in drought-prone seasons. These findings indicate that reproductive morphological traits such as thousand seed weight and number of pods per plant, offer far higher predictive value for yield than raw climatic variables. Moreover, they emphasize the importance of technology selection, ensuring that key morphological parameters develop optimally within the specific climatic conditions of Dobrogea.

Although conventional tillage achieved a significantly higher mean yield (+261 kg/ha), the relatively narrow difference between systems suggests that no-till can ensure competitive productivity under supplemental irrigation. Similar results have been reported in conservation-based systems, where yield gaps between conventional and reduced tillage remained moderate under appropriate nutrient and water management (Małecka-Jankowiak *et al.* 2016, Macák *et al.*

2020). The strong relationship observed in the present study between thousand seed weight (TSW) and yield ($r = 0.72$) is consistent with findings of Neugschwandtner *et al.* (2020), who emphasized the importance of yield structure components in determining final productivity in pea crops. Moreover, no-tillage systems have been reported to enhance compensatory growth responses in legume-based systems, particularly under stress conditions (Zhao *et al.* 2019, Stroe and Miron, 2025). Long-term studies also indicate that conservation tillage contributes to improved soil structural stability and resilience under drought-prone conditions (Woźniak and Rachoń 2019.

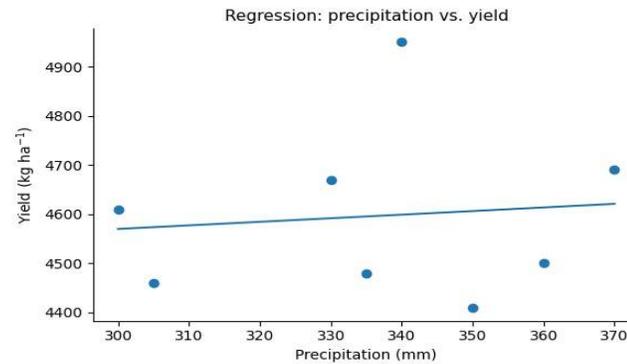


Fig. 9. Regression: precipitation vs. yield.

Janusauskaite 2023). These findings are also consistent with recent regional studies from Dobrogea. Stroe and Panaitescu (2025) and Ianculescu *et al.* 2026 reported that the transition from conventional to reduced tillage technologies can maintain stable yields while improving operational efficiency under local pedoclimatic conditions. Similarly, Mihai-Florea *et al.* (2025) highlighted the role of modern technological solutions and digital farm management in optimizing resource use in Dobrogea farming systems. The agronomic relevance of tillage systems is also linked to soil fertility dynamics and crop rotation effects, as shown by Bucur (2018), who reported improved soil structure and productivity stability in corn-pea rotations under conservation practices. In addition, the adaptability of pea cultivars to different technological systems depends on their genetic background and physiological plasticity (Schroeder *et al.* 1993, Bojarszczuk, 2021).

The results of this study showed that conventional tillage resulted in slightly higher vegetative growth and yield of the pea variety “Nicoleta” under the pedoclimatic conditions of Dobrogea. However, the no-till system maintained stable and competitive productivity, particularly under supplemental irrigation. Thousand seed weight and number of pods per plant proved to be the main predictors of yield, while precipitation had limited influence due to controlled irrigation. These findings indicate that the “Nicoleta” variety adapts well to both tillage systems and that no-till represents a viable option for sustainable pea cultivation in semi-arid environments. These results support the adoption of conservation-oriented tillage practices for pea cultivation in the semi-arid conditions of Dobrogea.

References

- Adela J, Niță S, David G, Pișan P and Alda S 2010. The behaviour of some varieties of pea, soybean and lentils concerning the relationship bacterization-sowing period on the yield and quality in the Timiș Plain. *Res. J. Agric. Sci.* **42**(4): 82-87.

- Boincean B, Voloşciuc L, Rurac M, Hurmuzachi I and Baltag G 2020. Conservation agriculture: Manual for farmers and trainers. Unitatea Consolidată pentru Implementarea Programelor IFAD. [In Romanian].
- Bojarszczuk J 2021. The influence of soil tillage system on changes in gas exchange parameters of *Pisum sativum* L. *Agronomy* **11**(5): 1000.
- Bucur G 2018. The effect of soil tillage systems on some elements and conditions of soil fertility, and crop productivity in the corn–pea link. *In: Research on Field Crops in the Republic of Moldova*, pp. 29-34.
- Drew EA, Gupta VVSR and Roget DK 2007. Herbicide use, productivity and nitrogen fixation in field pea (*Pisum sativum*). *Aust. J. Agric. Res.* **58**(12): 1204-1214.
- Ianculescu G, Stroe TC, Miron L and Panaitescu L 2026. Impact of soil tillage systems on maize productivity, mechanization efficiency and economic performance under irrigated conditions in South-Eastern Romania, *J. Agric. Rural Dev. Stud.* **3**(1): 23-36.
- Janusauskaite D 2023. Productivity of three pea (*Pisum sativum* L.) varieties as influenced by nutrient supply and meteorological conditions in the boreal environmental zone. *Plants* **12**(10): 1938.
- Macák M, Candráková E, Đalović I, Prasad PV, Farooq M, Korczyk-Szabó J and Šimanský V 2020. The influence of different fertilization strategies on the grain yield of field peas (*Pisum sativum* L.) under conventional and conservation tillage. *Agronomy* **10**(11): 1728.
- Małecka-Jankowiak I, Blecharczyk A, Swędrzyńska D, Sawińska Z and Piechota T 2016. The effect of long-term tillage systems on some soil properties and yield of pea (*Pisum sativum* L.). *Acta Sci. Pol. Agric.* **15**(1).
- Mihai-Florea O, Stroe TC and Panaitescu L 2025. Theoretical model for implementing digital twins in farms from Dobrogea region, *Res. J. Agric. Sci.* **57**(1): 175-181.
- Mihuț C, Mateoc-Sîrb N, Duma-Copcea A, Niță S, Lațo I, Ciolac V and Okros A 2023. Assessing the state of fertility (quality) of the soils for sustainable agriculture in Remetea Mare, Timiș County, Romania. *Sci. Pap. Ser. Manag. Econ. Eng. Agric. Rural Dev.* **23**(2): 487-494.
- Neugschwandtner RW, Bernhuber A, Kammlander S, Wagentristl H, Klimek-Kopyra A and Kaul HP 2020. Yield structure components of autumn- and spring-sown pea (*Pisum sativum* L.). *Acta Agric. Scand. Sect. B Soil Plant Sci.* **70**(2): 109-116.
- Okçu G, Kaya MD and Atak M 2005. Effects of salt and drought stresses on germination and seedling growth of pea (*Pisum sativum* L.). *Turk. J. Agric. For.* **29**(4): 237-242.
- Panaitescu L 2016. Crop science - Cereals. Casa Cărții de Știință, Cluj Napoca. 226 pp [In Romanian].
- Payne WA, Rasmussen PE, Chen C, Goller R and Ramig RE 2000. Precipitation, temperature and tillage effects upon productivity of a winter wheat–dry pea rotation. *Agron. J.* **92**(5): 933-937.
- Santín-Montanyá MI, Zambrana E, Fernández-Getino AP and Tenorio JL 2014. Dry pea (*Pisum sativum* L.) yielding and weed infestation response under different tillage conditions. *Crop Prot.* **65**: 122-128.
- Schroeder HE, Schotz AH, Wardley-Richardson T, Spencer D and Higgins TJ 1993. Transformation and regeneration of two cultivars of pea (*Pisum sativum* L.). *Plant Physiol.* **101**(3): 751-757.
- Stroe TC and Miron L 2025. Agrotechnics. Laboratory practical manual for agriculture students. Sitech Publishing House, Craiova. 230 pp. [In Romanian].
- Stroe TC and Panaitescu L 2025. Assessment of the Transition from Conventional Soil Tillage to Minimum Tillage Technology in A Maize Crop with Three Hybrids – A Three-Year Case Study in Lanurile, Constanța County. *Int. J. Innov. Approaches Agric. Res.* **9**(3): 217-231.
- Șimon A, Rusu T, Chețan F and Chețan C 2017. The influence of the tillage system on yield and protein quantity in pea cultivation at ARDS Turda.
- Woźniak A and Rachoń L 2019. Effect of tillage systems on pea crop infestation with weeds. *Arch. Agron. Soil Sci.* **65**(7): 877-885.
- Zhao C, Chai Q, Cao W, Whalen JK, Zhao L and Cai L 2019. No-tillage reduces competition and enhances compensatory growth of maize (*Zea mays* L.) intercropped with pea (*Pisum sativum* L.). *Field Crops Res.* **243**: 107611.