BINDURA UNIVERSITY OF SCIENCE EDUCATION

DEPARTMENT OF CROP SCIENCE

A FRAMEWORK FOR PERFOMANCE OF FIELD PEA (*Pisum sativum L*.) UNDER DIFFERENT POPULATION DENSITIES: A CASE OF MLICHI, HURUNGWE DISTRICT, ZIMBABWE

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DEDICATION

This research initiative honors my parents, my sisters and all Zimbabwe smallholder and commercial field pea farmers.

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I want to start by giving thanks to the Almighty God for watching over me and guiding me in every step. He has made my routes clear and given me the energy to move forward. I would want to express my gratitude to my project supervisor, Prof Mandumbu, for all of his tremendous efforts to mentor me. He supported me, and I can thank him for the experience, knowledge, and skills I have now. I want to express my gratitude to my family and friends for their support and inspiration throughout the research process. I am really grateful for their affection and assistance. A special thank you also goes out to Mr Takavarasha, a friend and an advisor, who also gave me guidance and advice during the course of my project. Lastly, I would like to thank my father for giving me land to do my project and always reminding me that hard work is the cornerstone for success.

DECLARATION

I Mr. Evance Tafara Kondo (B201666B), declare that this project represents my work and this has not been submitted for a degree at this or any other University.

Evance Tafara Kondo

Signature …...........................   Date: 27 June 2024

This project has been submitted for examination with the approval of the University supervisor

Prof R Mandumbu

Signature…………………………...Date………………………

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ASTRACT

Field pea (*Pisum sativum*) is one of the most important grain legume crops in Zimbabwe. The experiment was conducted on the effect of plant density on growth yield and yield parameters of field pea cultivar, Green feast in 2023 cropping season at Pelele Farm in Mlichi, Karoi. Three intra row spacing (10cm, 15cm and 20cm) and three inter row spacing (30cm, 45cm and 60cm) were evaluated using one variety, Green feast on a plot size of 24.5m x 11m (269.5m^2). The experiment was carried out in a Randomised Complete Block Design (RCBD) with nine treatments replicated three times. Genstat Release 16.1 Copyright 2013, VSN International Ltd, computer software package was used to compute the Analysis of Variance (ANOVA). Planting spacing had very high significant effect ($p<0.001$) on number of pods per plant and grain yield. High significant effect ($p=0.038$) on the number of grains per pod was observed. Planting spacing had no significant effect ($p=0.142$) and ($p=0.655$) on plant height and pod length respectively. The overall highest grain yield (3.124tonnes/ha) was recorded when Green feast was planted in 45cm x 15cm followed by grain yield of (2.936tonnes/ha) under 45cm x 20cm and the lowest grain yield (1.811tonnes/ha) was obtained in 60cm x10cm. Based on the experiment results, the farmer can use a spacing of 45cm x 15cm for best yields in Mlichi Farming Area.

Key words: Field pea, Green feast, Intra row spacing, Inter row spacing, Population densities, Plant height, Pod length, Pods per plant, Grains per pod, Grain yield.

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ANOVA	-	Analysis Of Variance
RCBD	-	Randomised Complete Block Design
CV	-	Coefficient of Variation
LSD	-	Least Significant Difference

CHAPTER ONE

1.0 Introduction

Field pea, scientifically known as Pisum sativum L., is a legume crop that thrives in cold climates. It is cultivated for many uses in different regions of the globe. People first planted it 9000 years ago alongside grains like wheat and barley, making it one of the oldest crops in the world (McPhee, 2003). It is a native crop of Lebanon, Syria, Iraq, Iran, Turkey, Israel, Jordan, and Ethiopia. Its long history of domestication and its versatility as a vegetable, pulse, and forage make it one of the most significant dietary legumes in the world. The field pea is the most significant highland pulse, primarily consumed by humans in Ethiopia. The field pea, the most significant annual cool-season pulse crop, is a diploid that self-pollinates, highly valued as a protein-rich meal. The world's highlands, tropical areas, and colder climates extensively cultivated it. Choudhury et al. (2007) state that a variety of soil types, from heavy clays to high sandy loams, can support the crop's growth, but it cannot tolerate salinity or moisture.

1.1 Background of the study

Field pea (Pisum sativum L.) is one of the most important grain legumes in the world. The grain is a primary source of plant-derived protein for animals' diets. Field peas are native to South West Asia and have been cultivated in the United States for an extended period. It was one of the first crops that humans farmed (Zohary and Hopf 2002). According to Ghafoor and Arshad (2008), it is the third highest producer of food legumes globally. The current top nations in field pea production are the Soviet Union, China, and Russian Federation, together accounting for over 70% of the entire crop area (FAOSTAT, 2006). Field pea cultivation in Southern Africa is mostly concentrated in regions such as Western Cape, Mpumulanga, and Free State in South Africa. The two predominant cultivars cultivated in Zimbabwe are the mange tout and sugar snap types. Mange tout, also referred to as snow peas, are legumes with flat pods, harvested when the peas are still immature and consumed whole. Sugar snap peas possess thick pods that are consumed in their whole. People often use sugar snaps, a hybrid of regular peas and mange tout, in salads. Due to insufficient winter rainfall and a lack of knowledge about the appropriate population density, only a small number of farmers in the Mlichi Farming Area cultivate field pea.

This grain legume is rich in nutrients and provides a significant amount of energy. It is also a valuable source of crude protein. If peas cultivated for human consumption or seed fail to meet market standards, they may find their way into the market as cattle feed. Canada primarily cultivates field peas for export to Europe, where animal feed is their primary use. Field pea has the advantage of being able to fix nitrogen, making it one of the most efficient nitrogen fixing crops. As a result, the plants have little need for additional nitrogen supplementation. This crop is crucial for restoring soil fertility as it acts as a rotation crop that fixes atmospheric nitrogen. Additionally, it serves as a rotating crop that has a vital role in reducing disease outbreaks and weeds (Hoorman et al., 2009).

Studies have shown that cultivating field pea in crop rotations before small grains may lead to increased yields of the small grain. This may be partially related to the disruption of insect cycles that might occur as a result of crop rotations. Including a third unrelated crop further amplifies this advantage. The shorter maturation time of field peas may potentially provide a moisture advantage to the subsequent crop. Field peas, a type of pulse grain, grow annually during the cold season, exhibiting either an indeterminate or determinate type (Zohary and Hopf, 2002), with most cultivars displaying an indeterminate growth pattern (Cousin, 1979). Field pea crops thrive in regions with an ideal annual rainfall of 600 to 1000 mm. They are not well-suited to dry conditions, and any drought occurring during the blooming stage might have negative consequences. Field pea is well suited to a diverse array of soils, ranging from light sandy loams to heavy clays. However, it is not tolerant of waterlogged conditions. The crop thrives on clay soils with a pH level between 5.5 and 6.8 (Anderson et al., 2007).

The choice of fertilizer is contingent on soil test results, and it is critical to inoculate field peas with Rhizobium leguminosarum in order to increase growth. Field peas need significant amounts of potassium and phosphate to facilitate nitrogen fixation and accelerate the maturation process. The recommended basal dressing is 500kg per hectare of compound D. Three weeks later, an additional 100kg per hectare of Ammonium Nitrate should be applied, and at six weeks another 100kg per hectare of Ammonium Nitrate should be administered. The same rate of 100kg per hectare of Ammonium Nitrate should be treated during the flowering stage. After about seven to ten days after flowering, an application of 50kg of Muriate of Potash per hectare will be made.

Population density, referring to the number of plants per unit area, is a critical factor influencing crop growth, development, and yield. Optimal population density ensures that plants can effectively utilize available resources such as light, water, and nutrients. Proper spacing minimizes competition among plants, leading to better growth and higher yields (Gan et al., 2003; Yayeh, Fekremariam, & Oumer, 2014). Conversely, suboptimal densities can lead to overcrowding, which may result in poor air circulation, increased disease incidence, and reduced yield (Parihar, 1996; Stoker, 1975). On the other hand, too low a density can lead to underutilization of resources and suboptimal yields (McPhee, 2003).

Mlichi, located in the Hurungwe District of Zimbabwe, presents unique climatic and soil conditions that necessitate localized research for effective crop management. Zimbabwe's agriculture, particularly in rural areas, faces challenges such as variable rainfall patterns, soil fertility issues, and limited access to agricultural inputs. Field pea cultivation in this region can play a significant role in improving food security and soil health (Zohary & Hopf, 2002; Khandan Benjandi et al., 2010).

Various studies have highlighted the impact of planting density on crop performance. For instance, Bhagwan Singh and Kalra (1989) examined the effect of sowing dates and plant spacing on the growth and productivity of pigeon pea, demonstrating that both factors significantly affect yield. Similarly, research by Biabani (2008, 2010) focused on the influence of planting patterns on the yield and yield components of pea, indicating that optimal row spacing and plant arrangements are crucial for maximizing productivity.

This foundational understanding highlights the necessity for optimizing field pea cultivation practices to maximize its benefits in diverse agricultural systems. The background emphasizes that optimal population density ensures efficient utilization of light, water, and nutrients, thereby maximizing crop productivity (Gan et al., 2003; Yayeh, Fekremariam, & Oumer, 2014). This critical insight provides a direct link to the study's focus on investigating the impact of different population densities on field pea performance. Understanding how population density affects growth and yield is essential for developing recommendations that can enhance field pea production.

The Hurungwe District of Zimbabwe presents unique agricultural challenges, including variable rainfall, soil fertility issues, and limited access to agricultural inputs. Field pea cultivation in this region can address these challenges by improving food security and soil health (Zohary & Hopf, 2002; Khandan Benjandi et al., 2010). The need for localized research to determine the best agronomic practices for field pea in this specific context is evident. This necessity forms the basis for conducting the study in Mlichi, Hurungwe District, aiming to tailor recommendations to the local environmental conditions. The study make use of Hurungwe District in Mashonaland province as a case in point to assess the impact of performance of field pea under different population densities

Figure 1 Map of Hurungwe District

Source: https://images.app.goo.gl/WnQrAzShRZNhxqiRA

The study is premised on the background of several and continuous reviews of performance of field pea under different densities

1.2 Problem Statement

Mlichi in Hurungwe District, ward 22 has small holder farmers which range from A1 and A2 who cultivate field pea at a small scale due to the fact that they acquire low yields every year due to lack of knowledge on the appropriate spacing to use. Due to the lack of sufficient knowledge about the ideal population density for local field pea varieties, this inquiry was conducted to determine the most suitable spacing for field pea production, considering the continuous release of new varieties. The study will examine the efficacy of various spacing techniques in field pea cultivation in order to achieve increased crop yields. The study will provide the foundation for making suggestions to the farmers in Mlichi Farming Area, ward 22 about the optimal population density to use in field pea cultivation.

1.3 Justification of the study

This section discusses the importance of undertaking the study.

1.3.1 Addressing Nutritional and Agricultural Needs

Field pea (Pisum sativum L.) is an essential crop for addressing both nutritional and agricultural needs, particularly in regions like Mlichi, Hurungwe District, Zimbabwe. It provides a high-protein food source and contributes to soil fertility through nitrogen fixation, making it a valuable component of sustainable agricultural systems (Choudhury, Tanveer, & Dixit, 2007; Hoorman, Islam, & Sundermeier, 2009). Given the importance of field pea in improving food security and promoting sustainable farming practices, optimizing its cultivation is crucial.

1.3.2 Importance of Population Density Optimization

Optimal population density is vital for maximizing crop yield and resource use efficiency. Studies have demonstrated that appropriate planting density ensures efficient utilization of light, water, and nutrients, thereby enhancing plant growth and productivity (Gan et al., 2003; Yayeh, Fekremariam, & Oumer, 2014). In contrast, suboptimal densities can lead to issues such as overcrowding, poor air circulation, increased disease incidence, and reduced yield (Parihar, 1996; Stoker, 1975). Therefore, identifying the optimal population density for field pea is essential for maximizing its agronomic benefits and yield.

1.3.3 Local Agricultural Challenges

Mlichi, located in Hurungwe District, Zimbabwe, faces unique agricultural challenges, including variable rainfall, soil fertility issues, and limited access to agricultural inputs. These challenges necessitate localized research to develop effective agronomic practices tailored to the region's specific conditions. Field pea cultivation has the potential to address some of these challenges by improving soil health and providing a reliable protein source (Zohary & Hopf, 2002; Khandan Benjandi et al., 2010). However, without region-specific data on optimal planting densities, farmers may not achieve the full potential of this crop.

1.3.4 Building on Existing Research

Previous studies have highlighted the impact of planting density on the performance of various crops, including pigeon pea, chickpea, and field pea in different contexts (Bhagwan

Singh & Kalra, 1989; Biabani, 2008, 2010; Kent, Blaine, & Gregory, 2003; McKay, Schatz, & Endres, 2003). However, there is a gap in research specific to the conditions of Mlichi, Hurungwe District, Zimbabwe. This study aims to fill this gap by providing localized data on the optimal population density for field pea cultivation, thereby contributing to the broader body of knowledge and aiding in the development of region-specific agronomic recommendations.

1.3.5 Enhancing Agricultural Productivity and Sustainability

Optimizing population density for field pea in Mlichi can lead to several benefits, including increased crop yields, improved soil fertility, and more efficient use of resources. These outcomes can contribute to greater food security and sustainable agricultural practices in the region. By determining the best planting densities, this study can help farmers maximize their productivity and sustainability, ultimately leading to economic and environmental benefits.

1.4 Research Objectives

1.4.1 Main Objective(s)

i. To develop a framework of the effects of plant spacing on field pea growth parameters.
ii. To determine the effects of plant spacing on field pea grain yield

1.4.2 Specific Objectives

The study will achieve to achieve the following objectives:

i. To determine the effects of plant spacing on plant height of on field pea.
ii. To find out the effects of plant spacing on field pea pod length.
iii. To ascertain the effects of plant spacing on the number of pods per plant on field pea.
iv. To examine the effects of plant spacing on the number of grains per pod on field pea.

1.5 Hypothesis

Ho: There is no significant difference on the effects of spacing on field pea growth parameters.

Ho: There is no significant difference on the effects of spacing in the grain yield of field pea.

1.6 Dissertation Outline

This research study was organised in six respective chapters. Chapter one introduced the study giving out the research background, statement of the problem, justification of the study, study objectives and then ending with hypotheses. Chapter two mainly focused on the literature review providing an overview of field pea, its origin and distribution, botany, varieties, areas cultivated, planting time, planting density, water and fertilizer application, pests and disease control, harvesting, storage and preserving and productivity. Chapter three presented methodology adopted in conducting the experiment as well as analytical ways which are engaged in data analysis so as to come up with baseline information for sound conclusion and recommendations. Chapter four presented results of the study which will then be followed by chapter five for discussions. In the sixth chapter, thus where conclusion and recommendations are presented.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

Field pea (Pisum sativum L.) is a critical legume crop that contributes significantly to nutritional security and sustainable agricultural practices due to its high protein content and nitrogen-fixing capabilities. Understanding the factors that influence its productivity and efficiency, particularly population density and harvesting methods, is essential for optimizing its cultivation. Population density plays a pivotal role in determining crop yield, growth, and resource use efficiency. Additionally, efficient harvesting practices are crucial for maximizing yield and minimizing post-harvest losses. This literature review explores the impact of population density on field pea productivity and the implications for harvesting practices, with a focus on providing insights applicable to the specific conditions of Mlichi, Hurungwe District, Zimbabwe. The review synthesizes findings from various studies to highlight the importance of optimizing planting density and harvesting techniques to enhance field pea production in different agro-ecological contexts.

2.1 Origin and distribution

Pisum sativum, or field peas, are native to South West Asia and have been grown in the US for a very long time. To name a few, the Soviet Union, India, Idaho, and Oregon are currently the top producers of field peas. North Dakota, South Dakota, Montana, and Minnesota started growing dry peas in the 1990s (FAO, 2012). In North Dakota, dry peas were grown on about 647.5 hectares in 1991 and 63535.6 hectares in 2002. The US exports more than seventy percent of its dry pea production abroad. Europe, Australia, Canada, and the United States are the main markets for field peas, with 182085.4 hectares of field peas under cultivation (Kent, 2003). In 2002, the United States cultivated over 121405.7 hectares of field peas. P. sativum is mostly grown in Southern Africa, in regions like the Western Cape, Mpumulanga, and Freestate.

2.2 Botany

Field pea (Pisum sativum L.) is a cool-season grain legume that grows annually. P. sativum is an annual herb with glabrous, bushy, or ascending stems that are often weak, round, and slender. P. sativum has roots that can reach a depth of 90 cm and are either determinate (bush or dwarf) or indeterminate (climbing). Field peas have hypogeal emergence, in which the cotyledons stay below the soil's surface, and growth typically takes 10 to 14 days. Spring frost is not a problem for seedlings (Bourion et al., 2003). Pale green leaves with a white bloom on top are characteristic of P. sativum. Pea stems and leaves get stiff and stringy as they get older (Kent et al., 2003). Plant winter-hardy cultivars such as Melrose, Granger, or Commonwinter early to ensure sufficient growth before soil freezing. People sow them in protected areas like rocky seedbeds or grain stubble (Clark, 2007).

A field pea plant has a single stem, but nodes below the initial blossom may branch out of it. The majority of pea cultivars yield self-pollinating, white to reddish-purple blooms. Each flower will produce four to nine seeds in each pod. According to Mathews (2003), pea cultivars have either an indeterminate or a determinate flowering behavior.

Indeterminate cultivars require 90–100 days to achieve maturity, however, they blossom for extended periods of time and can continue to ripen in cool, moist environments (Kent et al., 2003). Certain types will flower for a predetermined amount of time before maturing 80 to 90 days earlier. But within 61 centimeters of the soil's surface lies more than 75% of the root biomass. Field peas are a great rotating crop with small grains because of their shallow root structure and high water economy, especially in arid regions where conserving soil moisture is essential.

Most of the time, self-pollinating racemes that emerge in the leaf axils bear flowers. Depending on the flowering habit and weather at the time of planting, flowering usually starts 32–55 days after planting and lasts for two to four weeks on average. The roughly three-inch-long pods contain four to nine seeds. Pods contain enormous, nearly spherical seeds (1814 seeds per kilogram), which can be white, grey, green, or brown. P. sativum seedlings are resistant to damage from prolonged frost exposure. Nodes beneath the soil's surface will give rise to other shoots in the event that frost damage does occur and kills the main shoot. The plant needs cool, damp growing conditions and may tolerate severe frost, but heat kills it quickly, especially when coupled with humidity.

2.3 Varieties

Kinds and performance in selecting the many variations between types should serve as the basis for choosing the right field pea variety. When choosing which kinds to cultivate, one should take into account a number of characteristics, such as market class, yield potential, ease of harvesting, vine length, maturity, seed size, and disease resistance (McKay et al., 2003). While all pea varieties can serve as feed, only specific varieties are suitable for the green or yellow human edible market. The green and yellow cotyledon types are the two main market classes. Harvest easiness scores in trial results indicate crop harvestability, which is a crucial component in variety selection (McKay et al., 2003). Since it enables a quicker harvest with less equipment adjustment, most producers choose a cultivar that will stand upright at harvest (Kent et al., 2003). A wide variety of field pea varieties exists for producers across the region and a good source of information to aid in variety selection is field trial evaluations conducted by the NDSU research extension Centres across the state. The trials included the most promising varieties with information recorded on the important traits necessary for making proper variety selection (Kent et al., 2003). Farmers are urged to evaluate the most recent registered cultivars before planting, as varieties are subject to annual change based on ongoing research. Farmers primarily grow spring cultivars with white flowers with low levels of anti-nutritional factors. It clearly contributes to the biological nitrogen content of the organic farming system, and its contribution is predicted to rise (Mihov et al, 2002). Among these are the cultivars Aparna, Jayanti, Sapana, VL Pea-1, and Swati.

2.4 Areas cultivated

China and Russia are the two main P. sativum producing nations, followed by the US, Europe, Australia, and Canada. Major pea exporters, Europe, Australia, Canada, and the

United States cultivate more than 4.5 million acres. P. sativum is mostly grown in Southern Africa in regions like the Western Cape, Mpumalanga, and the Free State (Mathews C, 2003).

2.5 Planting period

P. sativum should be sown in April or early May to ensure that flowering takes place in June and early July, when temperatures may be cooler. Research on the best times to sow field peas in North Dakota has shown that yields drop dramatically if sowing is postponed past mid-May. This is because delayed sowing leads to mid-July flowering, which raises the risk of heat stress and disease issues like powdery mildew, which also lower yields (Kent et al., 2003). Planting too late will adversely affect flowering. At a seeding depth of 2–5 cm, the row spacing should be 15–30 cm. The variety chosen will determine the exact seeding rate, however, nine plants per square meter on average, or 75–100 kilograms per hectare is a good seeding rate (Mathews C, 2003). Field peas, an annual winter crop, matures in 95–100 days, grows for the same duration as wheat, and typically undergoes harvesting in Augus. Planting takes place in late fall and early winter in areas with few or no frosts (Mathews C, 2003).

2.6 Planting distance and density

In order to achieve equal pea maturity and optimal yields, plant density is a crucial variable. By creating the proper spacing between rows and plant rows, it is possible to attain the ideal plant density. Kent et al (2003) advises a plant population of 300,000 plants per acre, with the seed size determining the seeding rate.

Similar to cultivar, seeding rate has a significant impact on pea grain production, quantity, and quality. While higher seeding rates may make crops more competitive, the high cost of pulses can also have unfavorable effects on crop profitability. A healthy plant population may have a positive effect on increasing productivity. Compared to a tight spacing of 22.5 cm, an increased row spacing of 30 cm enhanced the dry weight of green beans (Pawar et al, 2007). According to Gen et al. (2007), chickpea grain output increased with higher plant population densities. In regions with a short growing season, using high plant densities typically boosts chickpea seed yield (Gen et al, 2003).

Samih (2008) observed that larger (20 cm by 30 cm) plant populations yielded more bush beans than smaller (60 cm by 30 cm) populations. This observation was consistent with findings from Gen et al. (2007), who found that higher plant densities in chickpeas led to better grain yields.

Dahmardeh et al. (2010) similarly proposed that a higher seeding rate could boost crops' capacity to compete, but they also pointed out that there is limited research and information available regarding how field pea cultivars respond in terms of growth and development to shifts in plant populations. Compared to 60cm by 30cm, a wider spacing of 60 by 45cm produced a much higher quantity of pods per plant (Mohammed et al., 1984). Reduced plant density led to an increase in the number of pods per plant, a finding also confirmed by Kakiuchi and Kobata (2004).

Wider spacing led to the largest plant height, likely due to the plants' unrestricted access to environmental resources such as light, water, and nutrients. According to Shirtliffe and Johnston (2002), row spacing had a considerable impact on plant height for various field pea cultivars. This finding is consistent with their findings. Similar to this, Yayeh et al. (2014) demonstrated that increased inter- and intra-row spacing led to the highest plant height for the Sefinesh field pea variety. Derya (2013), on the other hand, reported contradictory results, suggesting that pea plants with denser populations grew taller as a result of competition for sunlight.

The effects of the environment determine how much the yield increases. According to Parihar (1996), there was no discernible impact of row spacing on seed output. Nawaz et al. (1995) and Felton et al. (1996) discovered that although plant populations of 60 plants per square meter resulted in increased dry matter production and plant height, populations of 40 plants per square meter achieved the maximum grain yield

Derya Ozveren Yucel, (2013) showed that 400000 plant/ha of plant density gave the highest value of total pod number, followed by 300000 plant/ha of plant density, whereas the lowest value was obtained from 500000 plant/ha of plant density.

2.7 Fertilizer and irrigation applications

Field pea crops prefer optimal rainfall ranging from 600mm to 1000mm per annum. When the pods are almost full, administer a second irrigation, if necessary, after the first one at 45 days. One should irrigate with light and consistent pressure.

The findings of a soil test dictate the kind of fertilizer that should be applied. Potassium and phosphorus are relatively substantial requirements for field peas because they aid with nitrogen fixation and early maturity. Due to their great sensitivity to salt concentrations, field peas that are just germinating should not come into direct contact with fertilizers. Since P. sativum is one of the crops that fixes nitrogen the fastest, the plants don't need much more nitrogen; in fact, applying too much nitrogen will increase expenses without improving production (Mathews, 2003).

2.8 Diseases and pests

A few insect pests have a significant economic impact on the field pea industry. Aphids are tiny, light green insects that have the ability to harm plants. Aphid populations typically increase with the length of summer. In field peas, aphids do not become economically significant. Pea aphids' direct feeding can harm plants and impair yields by reducing seed set and seed size (Knodel et al. 2014). They weaken the plant by puncturing its tissue and then sucking its juices, particularly when the plant experiences stress due to dryness. Usually, aphid populations are kept under check by frequent, heavy rains or by beneficial insects like ladybird beetles and lace wings.

Disease frequently links to variations in pea yield. Bacteria, viruses, or fungi can cause plant diseases. The main fungi that cause diseases in peas are Fusarium wilt, Ascochyta blight, powdery mildew, and downy mildew. Peas are susceptible to several viruses, including pea common mosaic, pea enation mosaic, pea seed-borne mosaic, and top yellow, whereas Pseudomonas is the primary bacterial disease that affects peas (Cousin, 1997). One of the most dangerous aerial diseases of P. sativum L is Ascochyta blight, which is brought on by

Mycosphaerella pinodes (Garry et al, 1998). Up to 30% of yield losses may result from the illness (Allard et al., 1993). According to Garry et al. (1998), M. pinodes can infect every part of the pea plant that is above ground, causing multiple lesions and prolonged necrosis. The disease typically manifests itself around the time of blossoming (Tivoli et al., 1996). Regardless of the infection stage, the disease inhibits plant growth and lowers pea seed production because fewer seeds are produced with increasing disease severity on aerial organs (Garry et al, 1998).

If broader spacing keeps the crop's microclimate drier, larger row spacing may help lessen the strain from diseases. Field pea seed output increased when stand density (seed rate) decreased the quantity of weeds (Townley'Smith and Wright, 1993).

2.9 Harvesting

Harvesting is a critical stage in crop production that directly influences yield, quality, and overall productivity. For field pea (Pisum sativum L.), the timing and methods of harvesting are crucial for maximizing yield and minimizing losses. This study investigates how different population densities affect not only the growth and development of field pea but also its harvesting efficiency in Mlichi, Hurungwe District, Zimbabwe.

Population density has a significant impact on the harvesting efficiency of crops. Optimal population density ensures that plants are uniformly spaced, which can facilitate mechanical harvesting and reduce labor costs (Gan et al., 2003). Proper spacing minimizes plant competition, resulting in uniform maturation and easier access for harvesting equipment (Kent, Blaine, & Gregory, 2003; McKay, Schatz, & Endres, 2003).

The timing of harvesting is crucial for field pea, as harvesting too early or too late can affect both yield and quality. Early harvesting can lead to immature seeds with lower quality, while delayed harvesting increases the risk of shattering and loss due to adverse weather conditions (Biabani, 2008; McPhee, 2003). The optimal time for harvesting field pea is when the pods have reached physiological maturity, typically indicated by a change in pod color and firmness.

Mechanized harvesting is often preferred for field pea to reduce labor costs and improve efficiency. However, the success of mechanized harvesting depends on the uniformity of plant maturation and the accessibility of the crop, both of which are influenced by population density (Inanc & Yildirim, 2007). Proper row spacing and plant population ensure that harvesting equipment can move through the field without damaging the plants, thereby reducing harvest losses.

Research has shown that different planting densities can affect the ease and efficiency of harvesting. For instance, Yayeh, Fekremariam, and Oumer (2014) found that optimal plant spacing improved the uniformity of field pea maturation, facilitating more efficient harvesting. Similarly, Biabani (2010) noted that planting arrangements significantly influenced the ease of harvesting and the overall yield.

Ghafoor and Arshad (2008) emphasized the importance of uniform plant spacing in reducing harvest losses and improving seed quality. Their study highlighted that optimal population density not only enhances yield but also ensures that the crop can be harvested efficiently with minimal losses. Once the field peas reach their full maturity, gather and thresh them following sufficient sun exposure. Effective harvest management is crucial for the commercialization of field peas as seed or food for humans. Producing superior peas will enable growers to sell their harvest in the human food or seed markets for a higher price. The bulk of pods should have changed from green to yellow when peas attain physiological maturity. The crop develops starting with the lowest pods.

2.10 Productivity

Field pea can yield 20–25 qtls of grain and straw per hectare under irrigation, and 10-15 qtls of grains per hectare when fed with rain if the package of methods is enhanced. Productivity in agriculture refers to the efficiency with which crops convert inputs such as water, nutrients, and light into yield. For field pea (Pisum sativum L.), understanding the factors that influence productivity is crucial for optimizing cultivation practices. This study focuses on the role of population density in enhancing the productivity of field pea in Mlichi, Hurungwe District, Zimbabwe.

Population density significantly affects crop productivity by influencing plant growth, development, and resource utilization. Optimal population density ensures that plants have adequate space to access light, water, and nutrients, thereby reducing intra-specific competition (Gan et al., 2003). Studies have shown that appropriate planting densities can lead to higher yields by maximizing resource use efficiency (Bhagwan Singh & Kalra, 1989; Yayeh, Fekremariam, & Oumer, 2014).

Bhagwan Singh and Kalra (1989) demonstrated that both sowing dates and plant spacing significantly impact the growth and productivity of pigeon pea. Their findings highlight the importance of optimizing planting density to enhance crop performance. Similarly, Biabani (2008) found that row spacing and plant arrangements significantly affect the yield and yield components of pea. These studies underscore the critical role of planting density in determining crop productivity.

Research on field pea productivity across various regions has provided insights into the optimal conditions for maximizing yield. Kent, Blaine, and Gregory (2003) and McKay, Schatz, and Endres (2003) studied field pea production in North Dakota, emphasizing the importance of population density in achieving high yields. Their research indicates that adjusting planting density to suit local environmental conditions can significantly enhance productivity.

In Ethiopia, Yayeh, Fekremariam, and Oumer (2014) investigated the effect of plant spacing on field pea yield, finding that different spacing regimes can influence growth and productivity. These findings highlight the need for region-specific studies to determine the optimal planting densities that maximize field pea yield under local conditions.

2.11 Conclusion

The literature review highlights the critical influence of population density on the productivity and harvesting efficiency of field pea (Pisum sativum L.). Optimal population density ensures efficient resource utilization, minimizes intra-specific competition, and enhances crop yield. Studies demonstrate that appropriate planting densities lead to uniform plant growth and maturation, which are essential for efficient mechanized harvesting and reduced labor costs. Moreover, localized research is necessary to tailor agronomic practices to specific environmental conditions, such as those in Mlichi, Hurungwe District, Zimbabwe.

The findings from various studies underscore the need for region-specific recommendations to maximize the benefits of field pea cultivation, including improved yield, quality, and cost-efficiency. By addressing the unique challenges faced by farmers in different regions, optimized population density and harvesting practices can significantly contribute to sustainable agricultural development and food security.

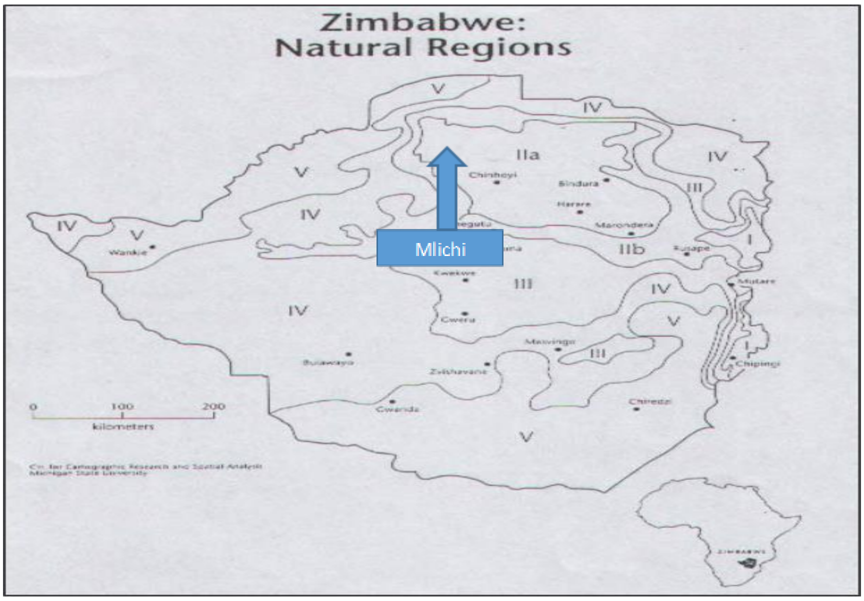
CHAPTER 3: MATERIALS AND METHODS

3.0 Introduction

Field pea (Pisum sativum L.), particularly the Green Feast variety, is a valuable legume crop that contributes significantly to agricultural productivity and soil health through nitrogen fixation. The optimization of planting densities and spacing is critical for maximizing yield and quality in field pea cultivation. This chapter details an experiment designed to evaluate the effects of different intra-row and inter-row spacings on the growth and yield of Green Feast field pea. Conducted using a Randomized Complete Block Design (RCBD) with three replications, the experiment involved nine treatments combining three intra-row spacings (10cm, 15cm, and 20cm) and three inter-row spacings (30cm, 45cm, and 60cm). The study was carried out in a controlled environment with specific agronomic practices, including precise land preparation, planting, watering, fertilizer application, and pest and disease control. The results of this experiment aim to provide insights into the optimal spacing configurations for enhancing the growth and yield of field pea under the specific conditions of the study site.

3.1 Experimental site

The trial was carried out in 2023 at Mlichi Farming area, Hurungwe District, Mashonaland West Province in Zimbabwe and the area of study lies in Natural Region two, -16.9649604, 29.8297584 and receives rainfall of about 1000 mm per annum. The mean annual temperatures range from 16°C to 30°C (Meteorological Service Department, 2017). The land has a slope of about 5% having clay soil.



KEY	
IIa	Natural region
	Mlichi Farming Area

Figure 2 Pelele Farming area. Source (Google map)

3.2 Experimental design and treatments

The experiment on the effects of spacing on one variety of field pea, Green feast was laid under Randomised Complete Block Design (RCBD) replicated three times. The experiment consists of combinations of three intra row spacings (10cm, 15cm and 20cm) and three inter row spacings (30cm, 45cm and 60cm). The gross plot size was 24.5m x11m and the land was divided into three blocks and each block had 9 plots. Each plot measured 3m x 2m and the net plot measured 1m x 1m. The treatments were randomly assigned to plots.

3.3 Agronomic Practices

3.3.1 Land Preparation

Firstly, the pegged land, 24.5m length by 11m width was dug, raked to break the soil clods for good soil seed contact and then beds of 3m length by 2m width were prepared. The land was divided into three blocks and each block contained nine plots.

3.3.2 Planting

I planted my field pea seeds, variety Green feast on the 9th of May 2023 and the treatments were randomly assigned to plots using three intra row spacing (10cm,15cm and 20cm) and three inter row spacing (30cm, 45cm and 60cm).

3.3.3 Watering

Soon after planting, irrigation water was supplied to field capacity through flood. Water application was done as per crop needs. The class A evaporation pan readings helped to calculate the required water needed and time of application. Watering cans were used to fetch water for irrigation purposes. The plots were irrigated to supplement rainwater so as to make sure seeds were going to germinate.

3.3.4 Fertilizer application

I firstly applied compound D on the planting day at 350 kg per hectare and then applied Ammonium Nitrate after six weeks of planting at 100kg per hectare.

3.3.5 Pest and disease control

Pests and disease were not a problem in my experiment. I used decis chemical to control cutworms. I applied the chemical soon after sowing the seeds at 100ml per 15 litres of water and this was done when the soil was moist.

3.3.6 Harvesting

The field pea was harvested on the 5th of September 2023. The net plot area harvested was measuring 1m by 1m which gave a total area of $1m^2$.

3.3.7 Storing and preserving

After harvesting and weighing my field pea grains, I then put them in a cool dry place that is in the storeroom.

3.4 Data collection

The following data was collected:

- Plant height which was measured after every two weeks.
- Pod length measured after every week.
- Number of pods per plant at maturity.
- Number of grains per pod at maturity.
- Grain yield at maturity.

3.5 Data analysis

Data was then subjected to Analysis Of Variance (ANOVA) using Genstat Release 16.1 Copyright 2013, VSN International Ltd, and computer software package for statistical analysis. Means were separated using Duncan's Multiple range Test at 5% level of significance. The data was firstly transformed from grams per square metre to kilograms per hectare before analysed using the following formula below:

Yield (kg/ha) =10000/plot area x plot weight/1000 x 112.5/100+%MC where,

10000 = Number of square metres in one hectare

Plot area = Net plot area

Plot weight = Number of grams of yield of pea attained in a net plot

1000 = Number of grams in a kilogram

112.5 = Constant value

100 = Constant value

%MC = Percentage moisture content.

3.6 Chapter summary

The experiment on the effects of different spacing configurations on the growth and yield of Green Feast field pea provided valuable insights into how intra-row and inter-row spacings influence various agronomic parameters. Despite the lack of significant differences in some growth parameters, such as plant height and pod length, the study revealed significant effects on yield components like the number of pods per plant and grain yield. The optimal spacing configuration identified through this experiment can guide farmers in maximizing field pea productivity. Specifically, the spacing of 45cm x 15cm demonstrated superior performance in terms of yield, suggesting that it offers a balance between plant population and resource availability. These findings underscore the importance of tailored agronomic practices and provide a foundation for further research to refine field pea cultivation strategies under diverse environmental conditions. By adopting optimal spacing practices, farmers can enhance crop yield and contribute to more sustainable and productive agricultural systems.

CHAPTER 4: RESULTS

4.0 Introduction

This section covers the presentation of results of the study. Field pea (Pisum sativum L.), specifically the Green Feast variety, is a significant legume crop valued for its high protein content and its ability to fix atmospheric nitrogen, thus enhancing soil fertility. Optimizing the growth conditions of field pea, including population density and spacing, is crucial for maximizing its yield and quality. Various studies have investigated how different planting densities affect the growth, development, and yield of field pea. This chapter examines the effects of different population densities on the growth height, pod length, number of pods per plant, number of grains per pod, and grain yield of field pea (Green Feast). The aim is to identify optimal spacing conditions that can enhance overall productivity and efficiency in field pea cultivation.

4.1 Effects of spacing on growth height of field pea, Green feast.

Different population densities showed no significant difference on growth height of field pea ($p=0.142$). The results indicated that there was no significant difference in 30cm x 15cm; 30cm x 20cm; 45cm x10cm; 45cm x15cm; 45cm x 20cm; 60cm x 10cm; 60cm x15cm. The highest growth height (73.33cm) was recorded in 60cm x 20cm whereas the lowest growth height (65.67cm) was recorded in 30cm x 15cm.

Table 1 : Effects of different plant densities on plant height.

Row spacing	**Plant Height**
30cm x 10cm	72.33bc
30cm x 15cm	65.67a
30cm x 20cm	69.00abc
45cm x 10cm	66.97ab
45cm x 15cm	69.00abc
45cm x 20cm	68.00abc
60cm x 10cm	69.00abc
60cm x 15cm	68.67abc
60cm x 20cm	73.33c
Grand mean	69.00
CV%	4.6
LSD	5.435
Pvalue	0.142

4.2 Effects of different densities on pod length on field pea, Green feast.

The results showed that there was no significant difference on pod length of field pea in all the nine treatments (Table 2). However, highest pod length (11.53cm) was recorded in 60cm x 10cm and lowest pod length (10.53cm) was recorded in 45cm x 10cm.

Table 2 : Effects of different densities on pod length on field pea, Green feast

Row spacing	**Pod Length**
30cm x 10cm	11.33a
30cm x 15cm	11.37a
30cm x 20cm	11.30a
45cm x 10cm	10.53a
45cm x 15cm	11.00a
45cm x 20cm	11.20a
60cm x 10cm	11.53a
60cm x 15cm	11.47a
60cm x 20cm	11.17a
Grand mean	11.21
CV%	5.4
LSD	1.045
Pvalue	0.655

4.3 Effects of plant densities on number of pods per plant on field pea, Green feast.

Different population densities showed significant difference on number of pods per plant on field pea ($p<0.001$). The highest number of pods (20) were recorded in density of 45cm x 15cm and lowest number of pods per plant (11.67) were recorded in 30cm x 15cm.

Table 3 : Effects of plant densities on number of pods per plant on field pea, Green feast.

Row spacing	**Number of pods per plant**
30cm x 10cm	12.33ab
30cm x 15cm	11.67a
30cm x 20cm	14.67bc
45cm x 10cm	14.00abc
45cm x 15cm	20.00d
45cm x 20cm	16.67c
60cm x 10cm	16.67c
60cm x 15cm	16.33c
60cm x 20cm	15.33c
Grand mean	15.30
CV%	10.1
Pvalue	<0.001

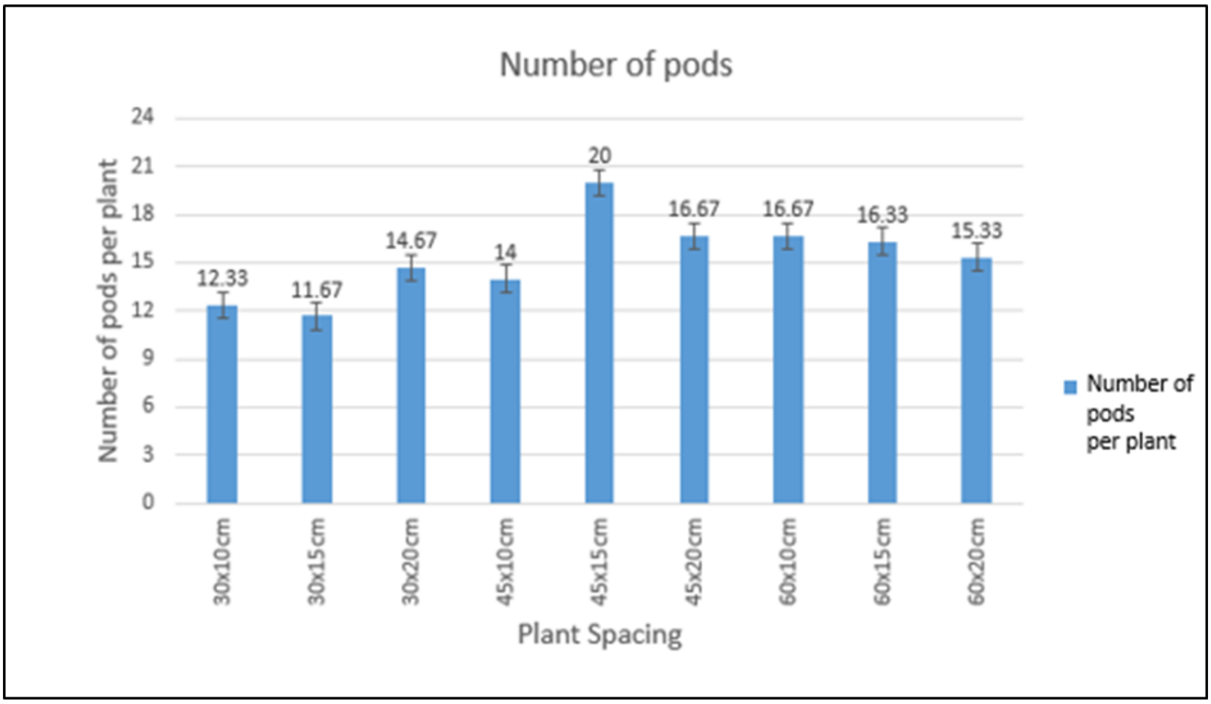


Figure 3 Effects of plant density on number of pods per plant

4.4 Effects of different spacing on the number of grains per pod on field pea, Green feast.

Experimental results indicated that there is significant effect on the number of seeds per pod of Green feast (p=0.038). The results indicated that there was a high significant difference between 30cm x 10cm and 45cm x10cm; 30cm x 10cm and 45cm x 15cm; 30cm x 10cm and 60cm x 10cm; 30cm x 10cm and 60cm x 15cm; 30cm x 10cm and 60cm x 20cm (Table 4, Fig 4).

Table 4 : Effects of different spacing on the number of grains per pod on field pea

Row spacing	**Number of grains per pod**
30cm x 10cm	5.333a
30cm x 15cm	6.667ab
30cm x 20cm	7.000ab
45cm x 10cm	7.000ab
45cm x 15cm	7.667b
45cm x 20cm	8.000b
60cm x 10cm	8.000b
60cm x 15cm	8.333b
60cm x 20cm	8.333b
Grand mean	7.37
CV%	13.7
LSD	1.751
Pvalue	0.038

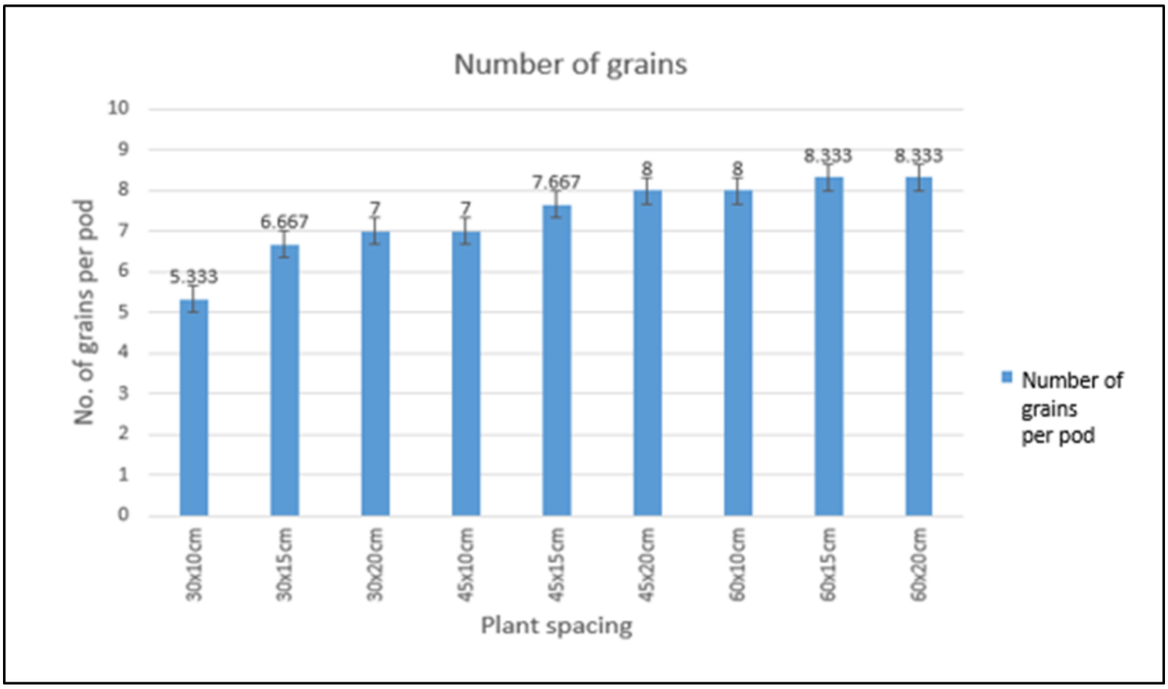


Figure 4 Effects of plant density on number of grains per pod

4.5 Effects of different plant population densities on grain yield of field pea, Green feast.

With respect to grain yield of Green feast, it was highly significantly (p<0.001) affected by planting spacing. According to the results attained, highest grain yield (3124kg/ha) was obtained at a spacing of 45cm x 15cm, whereas the lowest numerical results (1811kg/ha) was obtained from a spacing of 60cm x 10cm (Table 5, Fig 5).

Table 5 : Effects of different plant population densities on grain yield of field pea

Row spacing	**Grain yield**
30cm x 10cm	2173bc
30cm x 15cm	2317cd
30cm x 20cm	2552d
45cm x 10cm	2052ab
45cm x 15cm	3142e
45cm x 20cm	2936e
60cm x 10cm	1811a
60cm x 15cm	1902a
60cm x 20cm	1835a
Grand mean	23.00
CV%	6.2
Pvalue	<0.001

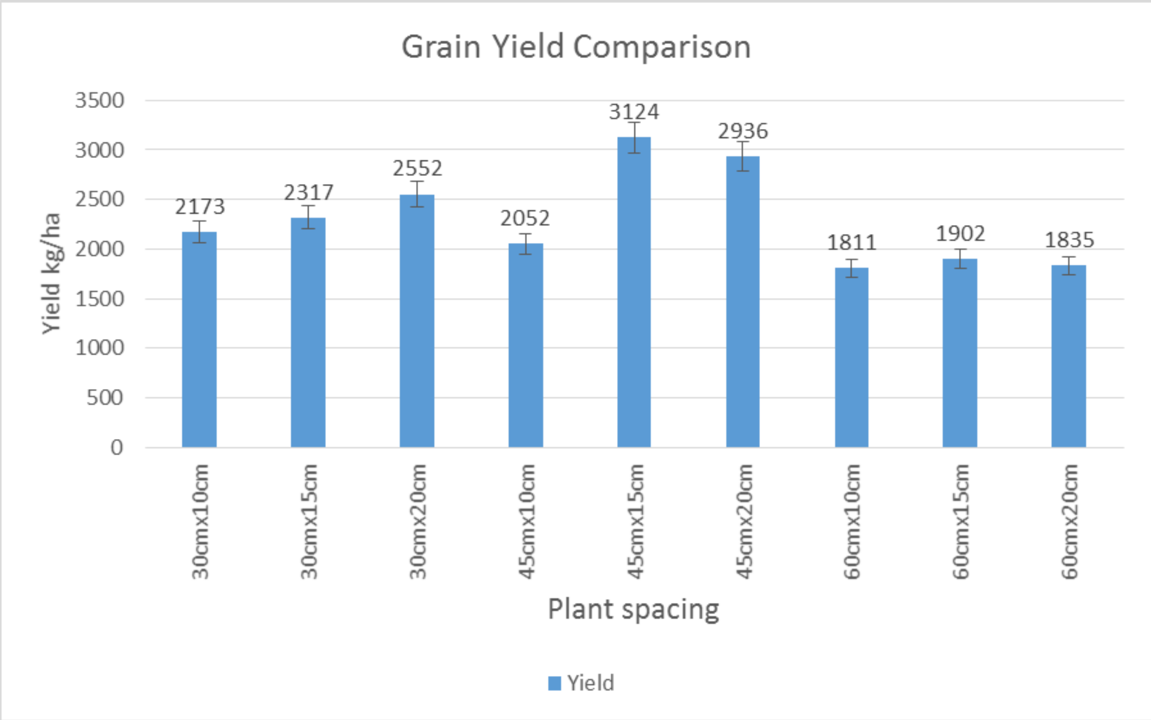


Figure 5 Effects of plant population density on grain yield of field pea

4.6 Chapter summary

The findings of this study reveal that population density has varying effects on different growth parameters of field pea (Green Feast). While the different planting densities showed no significant difference in growth height and pod length, they had a significant impact on the number of pods per plant, number of grains per pod, and grain yield. Specifically, the highest growth height was observed at a spacing of 60cm x 20cm, and the highest pod length was recorded at 60cm x 10cm. The most significant finding was that the number of pods per plant, number of grains per pod, and grain yield were highly influenced by planting density. The spacing of 45cm x 15cm yielded the highest number of pods per plant and the highest grain yield, indicating that this spacing optimizes resource use and enhances productivity.

These results underscore the importance of selecting appropriate planting densities to maximize yield and efficiency in field pea cultivation. Farmers in regions like Mlichi, Hurungwe District, Zimbabwe, can benefit from adopting optimal spacing practices based on these findings to improve their crop output. Further research is recommended to explore the interactions between different environmental factors and planting densities to develop comprehensive guidelines for field pea cultivation under diverse conditions.

CHAPTER 5: DISCUSSION

5.0 Introduction

Plant density is a critical factor influencing the growth and yield of field pea (Pisum sativum L.). Understanding how different spacing configurations affect various growth parameters and yield components can help optimize agricultural practices for better productivity. This chapter investigates the effects of different intra-row and inter-row spacings on the growth height, pod length, number of pods per plant, number of grains per pod, and grain yield of the Green Feast variety of field pea. Conducted under a Randomized Complete Block Design (RCBD) with three replications, the study aims to identify the optimal spacing that maximizes yield while ensuring robust plant development. By examining the impacts of nine different spacing treatments, this research provides insights that can guide field pea cultivation practices, ultimately contributing to improved agricultural efficiency and output.

5.1 Effects of spacing on growth height of field pea, Green feast.

Based on the data in table 1, the optimal spacing for plant growth was found to be 60cm × 20cm for the tallest plants (73.33 cm), and 30cm x 15cm for the shortest plants (65.67 cm). The plants in the wider spacing may be able to reach greater heights because they have easier access to water, nutrients, and light. Row spacing has a substantial effect on plant height for many field pea cultivars, according to Shirtliffe and Johnston (2002), lending credence to this finding. Additionally, Yayeh et al. (2014) demonstrated that the Selfinesh field pea variety exhibited its maximum plant height when grown with wider gaps between inter-rows and in-rows. Additionally, Naim et al. (2012) demonstrated that roselle plant height was unaffected by crop density. Derya (2013) found the opposite to be true, stating that pea plants have to grow taller in order to compete for sunlight, which is at odds with the present results.

5.2 Effects of plant densities on pod length of field pea, Green feast.

Data pertaining to mean values (Table2) showed that in relation to different spacing, pod length have not responded significantly. The highest pod length (11.53cm) was obtained from a spacing of 60cm x 10cm and the lowest pod length (10,53cm) was obtained from a spacing of 45cm x 10cm. Therefore, this entails that maximum pod length was attained at a wider row spacing whilst minimum pod length was obtained from a narrower spacing. Muhmud et al. (1997); Kumar et al. (1997) are in line with the results for they concluded that pod length increases with increase in the row spacing. These current results are in contradiction with Ihsanullah et al. (2002) who pointed out that pod length of field pea decreases by increasing the row spacing.

5.3 Effects of plant densities on number of pods per plant on field pea, Green feast.

The planting spacing had a very significant ($p<0.001$) impact on the quantity of pods per plant. According to Table 3 and Figure 3, the pod number was greatest (20) at a spacing of 45 cm x 15 cm and lowest (11.67) at a spacing of 30 cm x 15 cm. Consistent with the present findings, Biababi (2010) and Khandan et al. (2010) discovered that chickpea pod density significantly affected pod yield. While I observed a correlation between inter-row spacing and the quantity of pods produced by field pea plants, Yayeh et al. (2014) found the opposite to be true. Furthermore, Biabani (2008) also notes that there was no significant influence of density on pod per plant numbers.

5.4 Effects of plant densities on number of grains per pod on field pea

The findings indicated that the number of seeds per pod varied from 5 to 8, and the spacing had a very significant influence ($p<0.038$) on the number of seeds per pods, as shown in table 4. A strong correlation between seed production and the number of seeds per pod and the number of pods per plant was also shown in table 4. Results from a study by Yayeh et al. (2004), on the other hand, showed that planting spacing had no effect on the number of seeds per pod of field pea, and that the number of seeds varied from 4 to 5. According to Ali et al. (2012), the number of grains per pod of field pea varied between 6 and 7, and there was no significant impact of plant density on this variable.

5.5 Effects of plant densities on grain yield of field pea, Green feast.

The impact of planting spacing on Green Feast's grain production was extremely significant ($p<0.001$). According to Table 5, the grain yield was best at a spacing of 45cm x 15cm (3124kg/ha) and lowest at a spacing of 60cm x 10cm (1811kg/ha). Insufficient spacing may be the cause of the lowest yields, as it hinders the ability to accommodate the necessary population density per hectare. As a result, the grain yield is poor. Derya (2013) and Ali et al. (2012) came to similar conclusions, namely that seed output of field pea was greatly impacted by population density. Yields for small-seeded field pea cultivars (Megeri) are reduced when the intra-row and inter-row spacing is further increased, as shown by Yayeh et al. Grain production in chickpeas is enhanced by increasing plant density, according to Gan et al. (2007).

5.6 Chapter summary

The study on the effects of various spacing configurations on the growth and yield of Green Feast field pea revealed significant insights. While plant height and pod length were not significantly influenced by different spacings, the number of pods per plant, number of grains per pod, and grain yield showed notable variations. The optimal spacing of 45cm x 15cm resulted in the highest number of pods per plant and grain yield, highlighting the importance of moderate spacing for maximizing productivity. In contrast, the lowest yields were observed at the widest spacing (60cm x 10cm), indicating that excessively wide spacing reduces plant density and overall yield. These findings underscore the necessity of carefully selecting planting densities to balance resource availability and plant competition. The results contribute to a deeper understanding of how spacing affects field pea growth and yield, providing valuable recommendations for enhancing agricultural practices and achieving higher productivity.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Optimum plant population has a positive influence on boosting the output of field pea, Green feast. According to the findings of this experiment, the distance between plants had a substantial impact on the number of pods produced by each plant, the number of grains produced by each pod, and the total amount of grain produced. It was found that a spacing of 45 centimeters by 15 centimeters produced the largest number of pods per plant (20.00), while a spacing of 60 centimeters by 15 centimeters and 60 centimeters by 20 centimeters produced the highest amount of grains (8.333) per pod. Additionally, this spacing of 45 centimeters by 15 centimeters resulted in the highest grain yields of 3.124 tons per hectare. With all of this information at hand, it is possible to draw the conclusion that the optimal planting spacing for the area in question is 45 centimeters by 15 centimeters in field pea, Green feast.

6.2 Recommendations.

Based on the findings of this study on the effects of different spacing configurations on the growth and yield of the Green Feast variety of field pea (Pisum sativum L.), several recommendations can be made to optimize field pea production. Firstly, it is evident from the results that plant spacing significantly influences various growth parameters and yield components. The highest grain yield was achieved at a spacing of 45cm x 15cm. This configuration also produced the highest number of pods per plant, indicating that a moderate spacing allows for optimal utilization of available resources such as light, water, and nutrients. Therefore, it is recommended that farmers adopt a planting spacing of 45cm x 15cm for Green Feast field pea to maximize yield. This spacing strikes a balance between providing sufficient space for each plant to thrive and maintaining an adequate plant population density.

Additionally, while the plant height and pod length did not show significant differences across the various spacings, these parameters should not be overlooked. The tallest plants were observed at the widest spacing of 60cm x 20cm, likely due to reduced competition for resources. However, this wider spacing resulted in a lower overall yield, highlighting the importance of considering both individual plant health and overall crop productivity. Thus, while wider spacings can enhance individual plant growth, they should be balanced with the need to achieve higher yields per unit area.

In terms of agronomic practices, it is recommended that careful attention be paid to irrigation and fertilization schedules, as these were standardized in the study and contributed to the overall health and productivity of the plants. Ensuring that plants receive adequate water, particularly through supplemental irrigation during dry periods, is crucial for maintaining growth and development. Similarly, appropriate fertilization, such as the application of Compound D at planting and Ammonium Nitrate six weeks post-planting, should be adhered to for optimal nutrient availability.

Pest and disease management also emerged as a critical component of successful field pea cultivation. Although pest and disease issues were minimal in this study, preventive measures, such as the application of decis to control cutworms, proved effective. Farmers should continue to monitor their crops for potential pest and disease threats and take proactive steps to manage them, ensuring healthy plant growth and maximizing yield potential.

6.3 Recommendations for further study

While this study has provided valuable insights into the effects of different spacing configurations on the growth and yield of the Green Feast variety of field pea (Pisum sativum L.), there remain several areas that warrant further investigation to enhance our understanding and optimize cultivation practices. Two key areas for further study are the interactions between spacing and fertilization, and the effect of spacing on disease and pest incidence.

1. **Interactions Between Spacing and Fertilization**:

While this study standardized fertilization practices, further research could explore the interactions between different spacing configurations and various fertilization regimes. Understanding how spacing influences nutrient uptake and utilization could lead to more precise fertilization recommendations, optimizing both plant growth and yield. This area of study is particularly important because it can help develop integrated management practices that balance plant density with nutrient application, ultimately enhancing sustainable agricultural practices. Investigating various combinations of spacing and fertilizer types or application timings could yield valuable data on maximizing field pea productivity while maintaining soil health.

2. **Effect of Spacing on Disease and Pest Incidence**:

Although pest and disease issues were minimal in this study, the relationship between plant spacing and pest/disease incidence merits further investigation. Different spacings may influence microclimates within the crop canopy, potentially affecting the prevalence and severity of pests and diseases. Studies focusing on these interactions could lead to improved integrated pest management strategies. This research is crucial for developing more resilient cropping systems, as it can identify spacing arrangements that minimize pest and disease outbreaks, reducing the need for chemical interventions and promoting more sustainable farming practices. Detailed studies could examine specific pest and disease dynamics under various spacing scenarios, providing tailored recommendations for farmers.

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APPENDICES

Appendix 1: Analysis of variance for growth height of field pea, Green feast.

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TREATMENT	8	145.333	18.167	1.84	0.142
Residual	16	157.778	9.861		
Total	26	366.000			

Appendix 2: Analysis of variance for pod length of field pea, Green feast.

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TREATMENT	8	2.1667	0.2708	0.74	0.655
Residual	16	5.8333	0.3646		
Total	26	10.0067			

Appendix 3: Analysis of variance for number of pods per plant in field pea, Green feast.

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TREATMENT	8	152.963	19.120	8.02	<.001
Residual	16	38.148	2.384		
Total	26	195.630			

Appendix 4: Analysis of variance for number of grains per pod in field pea, Grain feast.

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TREATMENT	8	22.963	2.870	2.81	0.038
Residual	16	16.370	1.023		
Total	26	40.296			

Appendix 5: Analysis of variance for grain yield of field pea, Green feast.

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TREATMENT	8	5516034.	689504.	33.86	<.001
Residual	16	325830.	20364.		
Total	26	5909239.			