Effect of Plant Density on Mechanical Harvest Efficiency of New Mexico Pod-type Green Chile Pepper

Israel Joukhadar[1], Charles Havlik[1], and Stephanie Walker[1]

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Abstract. New Mexico green pod-type chile (*Capsicum annuum*) has significant importance as a vegetable crop. The cultivation and trade of New Mexico pod-type green chile are culturally significant within New Mexico (USA) and contribute to the state's economy by providing income and employment to farmers and through supporting industries. However, because of the high cost and limited availability of labor, New Mexico pod-type green chile acreage has declined. Traditionally, New Mexico pod-type green chile is hand-harvested when the fruit are full-size but physiologically immature. To preserve and expand the production of New Mexico pod-type green chile, the adoption of mechanical harvest technologies is essential. In 2015 and 2016, experiments were conducted at New Mexico State University's Los Lunas Agricultural Science Center (Los Lunas, NM, USA) to examine the effects of increased planting density on New Mexico pod-type green chile fruit size, plant architecture, and mechanical harvest efficiency. Two commercial New Mexico pod-type green chile cultivars, NuMex Joe E. Parker and AZ-1904, were direct-seeded on 17 Apr 2015 and 14 Apr 2016. On 11 Jun 2015 and 14 Jun 2016, three plant density treatments were implemented at 39,000 (high), 23,000 (medium), and 15,000 (standard) plants/acre. Before harvest, plant measurements, including height, width, height to first bifurcation, stem diameter, and number of lateral basal branches, were obtained. Plots were mechanically harvested using an inclined double helix harvester, and harvested material was sorted into marketable green fruit, machine-broken fruit, and nonpod plant material. Fruit measurements, including fruit weight, width, length, pericarp thickness, and number of locules, were obtained. Both cultivars exhibited a 9% increase in height to bifurcation accompanied by fewer basal branches grown at high density. Plant density did not significantly affect the fruit length, width, number of locules, and pericarp thickness. Plants grown at high density had an increased percentage of marketable fruit, with 'NuMex Joe E. Parker' having a higher percentage of marketable green fruit compared to 'AZ-1904'. The results demonstrated that an increase in planting density in production fields to 39,000 plants/acre coupled with cultivar selection enhanced efficiency in a mechanical harvest system.

New Mexico pod-type chile (*Capsicum annuum*) is an important agricultural crop in New Mexico. The total chile production in New Mexico was 53,300 tons in 2022, with a total value of $46 million (US Department of Agriculture National Agricultural Statistics Service 2022). This industry yields two main consumer products, red and green chile. Green chile is cultivated primarily for the fresh and/or processed market and is harvested when it is full-size but physiologically immature. In contrast, red chile remains on the plant for further maturation, eventually turns red, and is harvested to be dried and ground into a product. The harvesting methods differ for these two chile types. Green chile is hand-harvested, thus ensuring the best quality for its intended use in the fresh or processed market (Funk et al. 2011). However, the red chile crop is predominately mechanically harvested to streamline the process of collecting the dried pods (Walker and Funk 2014). Some dual-purpose cultivars allow for both red and green fruit to be harvested from the same plant, depending on the harvest time (Coon et al. 2023). However, to meet specific market demands, fields may be exclusively dedicated to the production of either red or green chile.

New Mexico pod-type green chile is a labor-intensive crop, with 50% of its production cost being harvest labor (Takele et al. 2013). As labor costs and shortages increase, there is an overwhelming need for New Mexico pod-type green chile producers to have access to information regarding optimal mechanical harvest practices. Efficient mechanical harvest requires the alignment of the following three production elements: the picking mechanism, crop plant architecture, and cultivation practices. If these production elements are not properly managed for mechanical harvesting, then the mechanical harvest will be inefficient and crop yield will be reduced. Mechanical harvest efficiency is characterized as the percentage of machine-harvested fruit deemed marketable; a greater percentage of marketable fruit corresponds to heightened efficiency. Research conducted over the past two decades has demonstrated the ideal picking mechanism (Funk and Walker 2010) and plant architecture (Joukhadar et al. 2018; Palevitch and Levy 1984) for New Mexico pod-type green chile. The most efficient picking mechanism (an inclined double-open-helix picking head) coupled with the optimal plant architecture (tall, upright plants with fruit set higher on the plant and fewer basal branches) will increase mechanical harvest efficiency. To improve plant architecture, it is necessary to identify both optimal cultivars and planting density.

Planting density is a cultivation practice that influences yield (Locascio and Stall 1994) and plant architecture (Decoteau and Graham 1994; Paroissien and Flynn 2004). For New Mexico pod-type green chile, it is customary to plant approximately 15,000 plants per acre (Bosland and Walker 2014). Denser planting of chile has been associated with taller plant growth (Decoteau and Graham 1994) and fruit set higher on the plant (Paroissien and Flynn 2004), which are both desirable traits for an efficient mechanical harvest system. Denser planting has been shown to increase yield per acre for bell pepper (*Capsicum annuum*) and chile when harvested by hand (Locascio and Stall 1994) and chile

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[1]Department of Extension Plant Sciences, New Mexico State University, 945 College Drive, Las Cruces, NM 88003, USA

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I.J. is the corresponding author. E-mail: icalsoya@nmsu.edu.

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harvested for red fruit by mechanical means (Wall et al. 2002).

Enhancing the mechanical harvest efficiency of New Mexico pod-type green chile could be achieved by increasing the percentage of machine-harvested marketable fruit or decreasing the percentage of machine-broken fruit (Walker and Funk 2014). The relationships between increased planting density, plant architecture, and mechanical harvest efficiency of New Mexico pod-type green chile have not been investigated. Our hypothesis is that higher plant density will stimulate the growth of taller plants with higher fruit set. The primary objective of this research was to investigate the influence of plant density and cultivar on New Mexico pod-type green chile growth and its mechanical harvest efficiency.

Materials and methods

Trials were conducted at the New Mexico State University Agricultural Science Center (Los Lunas, NM, USA) in 2015 and 2016 (34.46°N, −106.45°W, elevation 4839 ft), with an average of 6 inches of precipitation annually. The soil is mapped as a Gila Loam. The Gila series consists of very deep, well-drained soils formed in stratified alluvium. Gila soils are on alluvial fans and flood plains.

Experimental design and field management. This experiment was a randomized complete block design with treatments consisting of full factorial combinations of two cultivars and three plant densities. Each treatment combination was replicated five times. The field was direct-seeded on 17 Apr 2015 and 14 Apr 2016, with two industry standard green New Mexico pod-type cultivars, NuMex Joe E. Parker (New Mexico State University, Las Cruces, NM, USA) and AZ-1904 (Curry Chile and Seed Co., Pearce, AZ, USA), into furrowed beds 40-ft-long spaced 2.5 ft apart. During the growing season, the field was managed according to best management practices in terms of flood furrow irrigation, fertilization, and weed control (Bosland and Walker 2014). The field was irrigated as needed, approximately every 7 to 10 d. The approximate amount of water applied to the field through surface irrigation was a total of 4 acre ft for the entire growing season. Urea was applied at the recommended level of 300 lb/acre of nitrogen for the entire season split into a preplant and monthly applications. Preplant fertilizer (16N–3.5P–6.6K; Helena Chemical Company, Albuquerque, NM, USA) was applied at 312 lb/acre. The remainder of the fertilizer was applied once per month for 3 months (46N–0P–0K; Helena Chemical Company) at a rate of 181 lb/acre. Cultivation and weeding occurred once per week. On 11 Jun 2015 and 14 Jun 2016, the 40-ft plots were thinned to 39,000, 23,000, and 15,000 plants per acre during the vegetative growth stage.

Plant measurements. Before harvest, the middle 30-ft section of the 40-ft plot was flagged and designated as the harvest area. Plants were counted within the harvest area. For the evaluation of plant architecture traits, six randomly selected plants were selected from within the harvest area. Each plant was given a number, and a random number generator was used to identify the plants for measurement. The plant architecture measurements encompassed several parameters. Plant width (cm) was measured at the widest area of the plant. Plant height (cm) was measured from the base of the stem starting at ground level to the highest point of the plant. Height to bifurcation (cm) was measured as the distance from the base of the stem starting at ground level to the point of the first division of the plant into two lateral branches. The number of basal branches (count) was measured as the number of lateral branches growing from the base of the stem below the first bifurcation.

Harvest. On the day of harvest, the picking mechanism (Etgar Moses 1010 Mechanical Harvester; Etgar Elad Ltd., Bet-Lehem-Haglilit, Israel) (Fig. 1) was prepared according to the recommended specifications. This harvester uses a power takeoff-driven, single-row, counter-rotating, and double-open-helix model for picking. The double-helix portion rotates to knock the fruit off the plant (Fig. 2). Subsequently, the detached fruit moves upward on the conveyor belts for collection (Fig. 2). The harvester and conveyor belts are powered by two hydraulic pumps; for this study, they were both set at level three. The speed of the double-helix was also set to three on the hydraulic speed control valves to ensure minimal damage to plants and fruit during the harvesting process. The harvester was operated by a tractor (John Deere 2640; John Deere & Company, Moline, IL, USA) in gear one that was moving at a speed of 1.1 mph. To maintain consistency, the settings of both the harvester and tractor remained unchanged throughout the entire harvest in both years of this study.

Yield measurements. On 2 Sep 2015 and 31 Aug 2016, plants were harvested at the green and full-size fruit stage. Before harvest, fallen fruit in the furrows were removed from the field because these fruits were not part of the study. Harvested materials from each plot were sorted into the following categories: marketable green (intact, whole, unblemished green fruit suitable for the market); machine-broken (fruit severed or damaged by the harvesting machine during the process); and nonpod plant material (sticks and leaves that were harvested by the machine). After completing the mechanical harvest in a plot, any fruit that fell to the ground during the process was manually collected, weighed separately, and categorized as ground fall fruit loss. Additionally, some fruit remained on the plants after the mechanical harvest. Those fruit were hand-harvested and designated as unharvested fruit remaining on plants. All sorted material was placed in bins and weighed.

Fruit measurements. Ten representative fruit from the marketable green fruit category were selected for fruit measurements. Fruit width (cm) was measured across the top at the shoulder, but below the calyx. Fruit length (cm) was measured from the top of the shoulder to the apex. If the fruit was curled, then the entire length of the fruit was measured by rolling the fruit from shoulder to apex on the ruler. Fruit was cut in half at the shoulder, and the pericarp thickness (mm) was measured at three representative points with a digital caliper (500-171-30; Mitutoyo, Kawasaki, Japan).

Statistical analysis. Our primary goal was to evaluate the influence of cultivar and plant density on mechanical harvest yields, fruit morphology, and plant architecture traits of New Mexico pod-type green chile. The effects of plant density and cultivar were tested using a mixed model with fixed effects for plant density, cultivar, year, and a combination of interactions. A random effect for replication was included to account for environment-

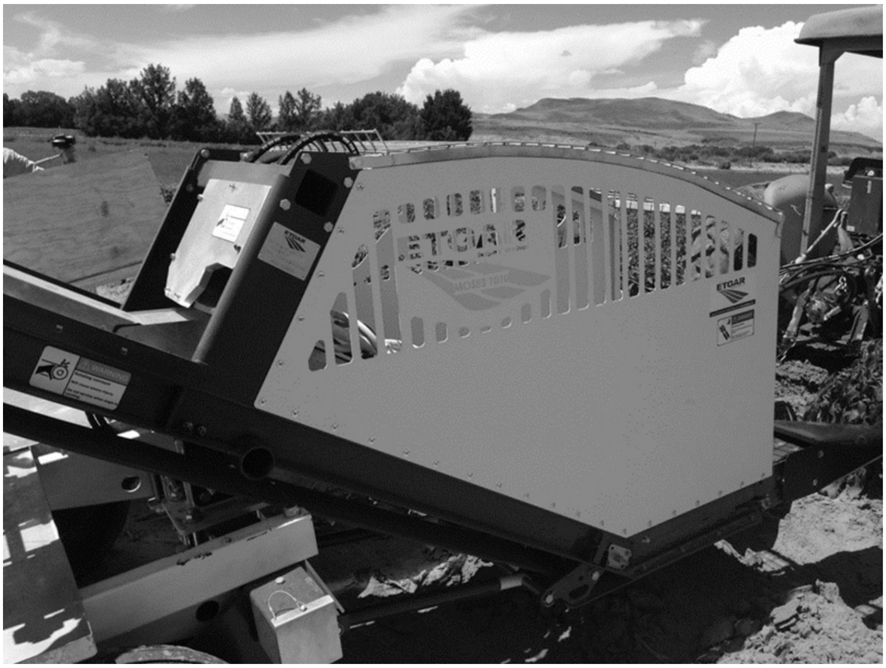

Fig. 1. Side view of the picking mechanism for New Mexico pod-type chile.

related plant loss after thinning. If a factor or interaction was significant, then separation was completed with the Tukey-Kramer test at $P \leq 0.05$. All statistical analyses were conducted using statistical software (PROC GLIMMIX, SAS version 9.4; SAS Institute Inc., Cary, NC, USA).

Results

Plant and fruit measurements. The effect of year did not impact any of the plant architecture measurements (Table 1). The only fruit morphological trait that was statistically different between years was fruit width. Because most response variables demonstrated no differences between the years, plant and fruit measurement data were consolidated across both years for the purpose of the analysis. All main effect interactions were not statistically significant; therefore, the main effects for each response variable were evaluated. Plant height, height to bifurcation, and the number of basal branches were influenced by the plant density and choice of cultivar (Table 1). Plants cultivated in the high-density spacing treatment displayed the greatest height, although this was not significantly different from the plant height in the standard plant density plots. 'NuMex Joe E. Parker' plants were 14% taller than 'AZ-1904' plants. Previous studies have indicated that taller, upright plants tend to have enhanced mechanical harvest yield (Joukhadar et al. 2018; Walker and Funk 2014; Wall et al. 2002). Plants subjected to the high-density treatment had a 9% increase in height to bifurcation compared with those in the standard density treatment. Additionally, 'NuMex Joe E. Parker' demonstrated a 14% greater height to bifurcation than 'AZ-1904'. Plants cultivated in the standard density treatment had the highest number of basal branches, whereas those grown in the high-density treatment had fewer basal branches. No significant differences were observed in the response variables of the basal stem diameter and plant width among any of the main effects or interactions.

Because none of the interactions among main effects had statistical significance in relation to fruit morphological traits, the focus was placed on evaluating the main effects. The cultivar selection had an influence on fruit length and pericarp thickness, whereas fruit width, number of locules, and pericarp thickness remained consistent across all main effects (Table 1). The fruit of 'AZ-1904' were 16% longer and had 10% thicker pericarps than the fruit of 'NuMex Joe E. Parker'.

Yield measurements. The influence of year was significant in terms of harvest efficiency (Table 2) and non-pod plant material (Table 3). However, because a considerable portion of the response variables exhibited statistical similarity across the years, and all interactions involving year as a factor showed no significant difference, the decision was made to collectively analyze the data from both years. Plant density treatments had an impact on yield components (Table 2). There was a significant increase in the percentage of marketable green fruit when cultivated at a high density (Table 2). Similar findings have been observed during previous research of bell pepper and New Mexico pod-type red chile (Locascio and Stall 1994; Paroissien and Flynn 2004; Wall et al. 2002), with

Fig. 2. Front view of the picking mechanism for New Mexico pod-type chile. The double-helix harvest mechanism and conveyor belts are shown.

Table 1. Impacts of year, plant density, and cultivar on plant architecture and fruit morphological traits of New Mexico pod-type green chile (*Capsicum annuum*) at the Los Lunas Agricultural Science Center, NM, USA.

	Plant height (cm)[i]	Plant width (cm)	Height to bifurcation (cm)	Basal stem diameter (cm)	Basal branches (no.)	Fruit width (cm)	Fruit length (cm)	Locules (no.)	Pericarp thickness (mm)
Year (Y)									
2015	66.4 ± 1.18	61.8 ± 1.04	20.7 ± 0.45	3.6 ± 0.27	1.7 ± 0.24	4.9 ± 0.06 a	20.4 ± 0.33	2.2 ± 0.02	4.3 ± 0.11
2016	64.1 ± 2.12	64.2 ± 1.45	21.7 ± 0.90	2.8 ± 0.81	1.3 ± 0.13	4.7 ± 0.04 b	20.8 ± 0.31	2.3 ± 0.03	4.1 ± 0.08
Plant density (PD)[iii]									
High	69.9 ± 1.37 a[ii]	62.6 ± 1.36	22.1 ± 0.56 a	2.5 ± 0.73	1.07 ± 0.17 c	4.9 ± 0.06	20.9 ± 0.44	2.2 ± 0.04	4.4 ± 0.12
Medium	62.5 ± 3.00 b	62.4 ± 1.96	21.3 ± 1.22 b	3.7 ± 0.61	1.6 ± 0.25 ab	4.8 ± 0.06	20.8 ± 0.38	2.2 ± 0.03	4.1 ± 0.10
Standard	63.3 ± 1.06 ab	64.0 ± 1.34	20.2 ± 0.65 c	3.5 ± 0.82	1.8 ± 0.27 a	4.8 ± 0.07	20.2 ± 0.33	2.3 ± 0.04	4.1 ± 0.13
Cultivar (C)									
NuMex Joe E. Parker	69.3 ± 1.17 a	63.9 ± 1.22	22.6 ± 0.72 a	2.8 ± 0.72	1.8 ± 0.14 a	4.7 ± 0.05	19.1 ± 0.16 b	2.2 ± 0.03	4.0 ± 0.07 b
AZ-1904	61.2 ± 1.88 b	62.2 ± 1.33	19.8 ± 0.60 b	3.6 ± 0.43	1.2 ± 0.23 b	4.9 ± 0.06	22.1 ± 0.16 a	2.3 ± 0.03	4.4 ± 0.11 a
Significance									
C	***[iv]	NS	***	NS	**	NS	***	NS	***
PD	***	NS	**	NS	**	NS	NS	NS	NS
Y	NS	NS	NS	NS	NS	***	NS	NS	NS
C × PD	NS	NS	NS	NS	NS	NS	NS	NS	NS
Y × C	NS	NS	NS	NS	NS	NS	NS	NS	NS
Y × PD	NS	NS	NS	NS	NS	NS	NS	NS	NS
Y × PD × C	NS	NS	NS	NS	NS	NS	NS	NS	NS

[i] Plant architecture and fruit morphological traits. Plant width = the widest area of the plant. Plant height = from the base of the stem starting at ground level to the highest point of the plant. Height to bifurcation = the distance from the base of the stem starting at ground level to the point of the first division of the plant into two lateral branches. Basal branches = number of lateral branches growing from the base of the stem below the first bifurcation. Fruit width = across the shoulder but below the calyx. Fruit length = the top of the shoulder to the apex. If fruit was curled, then entire length of the fruit was measured by rolling the fruit from the shoulder to the apex on the ruler. Pericarp thickness = fruit was cut in half at the shoulder and the pericarp thickness was measured. 1 cm = 0.3937 inches. 1 mm = 0.0394 inches.

[ii] Means ± *SE* followed by the same letter in a column within each effect are not significantly different according to the Tukey-Kramer test at $P \leq 0.05$. There were 60 observations for each response variable mean.

[iii] Standard = 15,000 plants per acre. Medium = 23,000 plants per acre. High = 39,000 plants per acre. 1 plant/acre = 2.4711 plants/ha.

[iv] NS, *, **, *** Not significant or significant at $P \leq 0.05$, 0.01, or 0.001, respectively.

high plant densities increasing the yield per acre. Machine-broken fruit percentages (Table 2) and nonpod plant materials (Table 3) showed a significant increase at higher densities. It has been observed that as yield and plant height increased, nonpod plant material and machine-broken fruit also increase (Joukhadar et al. 2018). Conversely, ground fall fruit loss and the amount of unharvested fruit remaining on the plants remained unaffected by plant density.

The choice of cultivar influenced both harvest efficiency and the occurrence of machine-broken fruit (Table 2). 'NuMex Joe E. Parker' exhibited a significant increase in the percent of marketable green fruit and a reduction in the percentage of machine-broken fruit. The cultivar selection did not influence nonpod plant material, ground fall fruit loss, or unharvested fruit remaining on plants.

Discussion

The primary objective of this research was to investigate the impact of plant density and cultivar selection on the growth of New Mexico pod-type green chile and mechanical harvest yield percentages. Conventional New Mexico pod-type green chile production typically uses plant spacing with a standard density (15,000 plants/acre) (Bosland and Walker 2014).

The primary influences on our response variables were attributed to the individual main effects of cultivar selection and plant density. This is consistent with the results of other studies (Locascio and Stall 1994; Sandhu et al. 2021; Wall et al. 2002), thus highlighting the importance of cultivation decisions, such as plant density and cultivar selection. Extensive research of cultivar selection has been conducted, resulting in the introduction of New Mexico pod-type green chile cultivars optimized for effective mechanical harvesting (Walker et al. 2021). We found that of the two cultivars we evaluated, NuMex Joe E. Parker had a higher proportion of harvested marketable green fruit.

Ideal cultivar selection coupled with the best mechanical harvest production practices are necessary for New Mexico pod-type green chile production fields aiming to shift toward mechanical harvest systems because of high production costs. Our results showed that using a planting

Table 2. Impacts of year, plant density, and cultivar on mechanical harvest yields of New Mexico pod-type green chile (*Capsicum annuum*) at the Los Lunas Agricultural Science Center, NM, USA.

	Marketable green fruit (%)[i]	Machine-broken harvested fruit (%)	Ground fall fruit loss (%)	Unharvested remaining on plants (%)
Year (Y)				
2015	66.7 ± 1.06 a[iii]	16.5 ± 0.90	13.2 ± 1.66	3.7 ± 0.57
2016	63.5 ± 1.02 b	18.7 ± 0.86	12.2 ± 1.59	5.7 ± 0.53
Plant density (PD)[ii]				
High	68.3 ± 1.23 a	18.5 ± 0.32 a	8.7 ± 1.95	4.5 ± 0.65
Medium	64.1 ± 1.27 ab	16.8 ± 0.27 ab	14.5 ± 2.01	4.7 ± 0.71
Standard	62.3 ± 1.27 b	16.0 ± 0.57 b	16.5 ± 2.01	5.2 ± 0.67
Cultivar (C)				
NuMex Joe E. Parker	71.1 ± 1.04 a	13.3 ± 0.33 b	10.9 ± 1.66	4.7 ± 0.57
AZ-1904	58.9 ± 1.00 b	21.8 ± 0.34 a	14.5 ± 1.59	4.8 ± 0.53
Significance				
C	**[iv]	***	NS	NS
PD	**	**	NS	NS
Y	*	NS	NS	NS
C × PD	NS	NS	NS	NS
Y × C	NS	NS	NS	NS
Y × PD	NS	NS	NS	NS
Y × PD × C	NS	NS	NS	NS

[i] Machine-harvested response variables (percent of total harvested fruit). Marketable green fruit = intact, whole, unblemished green fruit suitable for the market. Machine-broken fruit = fruit severed or damaged by the harvesting machine during the process. Ground fall loss = any fruit that fell to the ground during the mechanical process that was manually collected and weighed separately. Unharvested remaining on plants = fruit that remained on the plants after the mechanical harvest that was hand-harvested and weighed.

[ii] Standard = 15,000 plants per acre. Medium = 23,000 plants per acre. High = 39,000 plants per acre. 1 plant/acre = 2.4711 plants/ha.

[iii] Means ± *SE* followed by the same letter in a column within each effect are not significantly different according to the Tukey-Kramer test at $P \leq 0.05$. There were five replicates for each response variable mean.

[iv] NS, *, **, *** Not significant or significant at $P \leq 0.05$, 0.01, or 0.001, respectively.

density of 39,000 plants per acre resulted in a higher percentage of machine-harvested marketable New Mexico pod-type green chile compared with the use of the conventional 15,000 plants per acre. The higher machine-harvested yield is potentially attributable to the increased plant height and height to bifurcation of plants that are grown in higher densities. Altered plant growth arises with higher plant densities (Grace and Tilman 2012) and is driven by intraspecific competition among crop plants. The impact of these constraints can yield positive or negative effects on plant growth, contingent on the specific resource being restricted.

Increasing plant densities can increase plant height, height to bifurcation, and height to fruit set, which are optimal mechanical harvest growth patterns. This can be attributed to the competitive response trait that is activated by the limitation in light that occurs at higher planting densities (Navas and Violle 2009). Because light is limited with higher densities, the plants increase in height to maximize light exposure, which, in turn, is beneficial for marketable machine harvest efficiency. Reduced numbers of basal branches have been associated with increased mechanical harvest efficiency (Joukhadar et al. 2018; Walker and Funk 2014). However, in this study 'NuMex Joe E. Parker' had greater mechanical harvest efficiency despite having more basal branches. Conversely, based on our results, there is a possibility that not only the number of basal branches but also the size and location are associated with increased mechanical harvest efficiency because cultivar NuMex Joe E. Parker had higher mechanical harvest efficiency with more basal branches. The height of the basal branches from the ground and/or the diameter of the branches may also impact mechanical harvest efficiency. Because the plants move into the picking mechanism (Fig. 2), the nose of the picking mechanism is alongside the basal stem of the plant; therefore, the location and/or diameter of the basal branches might also impact the harvest efficiency. Expanding and continuing research of this area would be useful to future cultivar development.

The overall yield is important with any crop. However, for New Mexico pod-type green chile to be marketable to the consumer or processor, it must also maintain an elongated fruit shape with wide shoulders below the calyx and a sharp point at the apex (Coon et al. 2023). Our findings demonstrated that an increase in plant density did not have a significant impact on fruit width, length, number of locules, and pericarp thickness, which are critical for consumer and processor acceptance. Other important traits of New Mexico pod-type green chile are flavor and pungency (heat level). Cultivation practices can have an impact on pungency (Bosland and Votava 2012); therefore, future research efforts should incorporate pungency and flavor assessments in response to cultivation practices.

Conclusion

Increasing plant densities is a promising method of increasing mechanical harvest efficiencies without impacting the fruit size and shape of New Mexico pod-type green chile, further encouraging the adoption of mechanization by chile producers. Furthermore, the choice of cultivar significantly influences mechanical harvest efficiency outcomes. Of the two cultivars investigated during this study,

Table 3. Impacts of year, plant density, and cultivar on machine-harvested nonpod material of New Mexico pod-type green chile (*Capsicum annuum*) at the Los Lunas Agricultural Science Center, NM, USA.

	Nonpod material (kg/75 ft^2)[i]
Year (Y)	
2015	4.3 ± 0.25 a[iii]
2016	3.0 ± 0.24 b
Plant density (PD)[ii]	
High	4.5 ± 0.26 a
Medium	3.8 ± 0.30 a
Standard	2.7 ± 0.27 b
Cultivar (C)	
NuMex Joe E. Parker	3.7 ± 0.86
AZ-1904	3.5 ± 0.82
Significance	
C	NS
PD	***[iv]
Y	**
C × PD	NS
Y × C	NS
Y × PD	NS
Y × PD × C	NS

[i] Nonpod plant material = sticks and leaves that were inadvertently harvested by the machine. 1 kg/ft^2 = 2.2046 lb/ft^2 = 10.7639 kg/m^2 .
[ii] Standard = 15,000 plants per acre. Medium = 23,000 plants per acre. High = 39,000 plants per acre. 1 plant/acre = 2.4711 plants/ha.
[iii] Means ± *SE* followed by the same letter in a column within each effect are not significantly different according to the Tukey-Kramer test at $P \leq 0.05$. There were five replicates for nonpod plant material means.
[iv] NS, *, **, *** Not significant or significant at $P \leq 0.05$, 0.01, or 0.001, respectively.

NuMex Joe E. Parker demonstrated superior mechanical harvest efficiency. Future research should focus on further enhancing production protocols and cultivar selection when cultivating New Mexico pod-type green chile to optimize mechanical harvest efficiency. This will enable producers to access crucial information that facilitates their shift toward automated harvesting systems, which is critical because of the increasing costs and decreasing availability of labor.

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