Evaluating Chickpea (Garbanzo Bean) for Adaptability to Eastern Oregon

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Abstract

Seven chickpea (*Cicer arietinum* L.) varieties were evaluated for suitability to eastern Oregon conditions. The chickpeas, six *kabuli* and one *desi*, were sown in mid-April 2002 and 2003 at the Columbia Basin Agricultural Research Center (CBARC) in Pendleton and Moro, Oregon. Data on plant stand, plant height, disease, phenology, and bean yield were collected. 'Myles', the only *desi* chickpea, produced the highest bean yield under both annual and fallow cropping systems. Unfortunately, *desi* chickpeas are low value chickpeas in the United States. The *kabuli* varieties produced higher yields and bigger beans when soil moisture was adequate (after fallow), but most produced lower bean yield and smaller beans when grown following wheat in a drought year. 'Sinaloa' appears to be the only *kabuli* that is well adapted to low soil moisture conditions. 'Sinaloa' produced >80 percent of grade A beans under both low and high yield potential conditions. The other *kabuli* varieties produced a high percent of grade A beans only under high yield potential conditions. The *desi* chickpea, 'Myles', produced feed and grade C beans. To obtain both high bean yield and a high percentage of grade A beans under both low and high yield potential conditions, we recommend 'Sinaloa'. The other *kabuli* varieties are best grown under high yield potential conditions**.** If bean yield is the only important factor, then 'Myles' is recommended for both low and high yield potential conditions.

Keywords: adaptability, bean size, chickpea, desi, garbanzo, kabuli

Introduction

The reduction of green pea production due the closure of Agrifrozen Foods, Inc. in Walla Walla, Washington in 2000 and the decline in contract acres of Chiquita Processed Foods, LLC in Milton-Freewater, Oregon has led to a search for a new legume crop in eastern Oregon. Chickpea has the potential to replace peas in the traditional wheat pea rotation. Being a relatively new commercial legume crop to northeastern Oregon, there is limited information on chickpea varieties adapted to this region. Chickpeas are classified as either *desi* (small-seeded) or *kabuli,* also called garbanzo (large-seeded) types. The *desi* chickpeas predominate in the Indian subcontinent while the *kabuli* chickpeas predominate elsewhere. *Kabuli* chickpeas dominate American production because of their high value as an ingredient at salad bars (Saxena and Singh 1987, Muehlbauer 1993, Singh and Saxena 1999). However, there is a small but steadily increasing production of *desi* chickpeas. The small amount of *desi* chickpea produced is currently marketed to ethnic communities in large cities. However, there are prospects of expanding production for export (Muehlbauer 1993). The objective of this experiment was to evaluate different chickpea varieties for adaptability to growing conditions in eastern Oregon.

Methods

To determine chickpea varieties adapted to eastern Oregon, seven varieties, namely 'Dwelley', 'Sinaloa', 'Evans', 'Myles', 'Sanford', 'Sierra', and 'CA99901604W', were sown at 3 seeds/ft^2 in mid-April of 2002 and 2003 at the CBARC, Sherman Experiment Station in Moro (11-inch rainfall) and at the CBARC, Pendleton Experiment Station in Pendleton (16-inch rainfall). With the exception of 'Myles', a *desi* chickpea, all varieties were *kabuli* chickpeas.

The chickpeas were grown under conventional tillage following wheat at Pendleton and after fallow at Moro. Data on plant stand, days to flowering, days to maturity, plant height, disease, bean yield, and bean size were obtained. Plant stand was obtained by counting plants along 3-ft sections of two rows from each plot. Days to flowering and maturity were recorded when 50 percent of plants in each plot had flowered or matured. Disease ratings were obtained by estimating the percent of plants per plot that were diseased. Plant samples were sent to the pathologist (Dr. R. Smiley) for diagnosis. Plant height was measured just before harvest. A plot combine was used to harvest the chickpeas. The chickpeas were graded by passing them through sieves. In 2002, beans that did not pass though sieve no. 22/64 were classified as grade A and those that passed through sieve no. 22/64 but did not pass through sieve no. 18/64 were classified as grade B. Beans that passed through sieve no. 18/64 were classified as feed. In 2003 we adopted a more stringent grading system where beans were classified as grade A if they did not pass through sieve no. 22/64; grade B if beans did not pass through sieve no. 20/64; grade C if beans did not pass through sieve no. 18/64; and feed grade if beans passed through sieve no. 18/64. On average, grade A beans sell for $0.18-0.23/lb and grade B beans sell for $0.10-0.15/lb. The C and feed grade can sell for $60-70/ton (Ferrel 2004).

Results and Discussion

In 2002, Pendleton and Moro received 13.0 and 8.4 inches of precipitation, respectively. In 2003, precipitation was higher at both Pendleton (15.4 inches) and Moro (9.3 inches). Because 2002 was a drought year, fallow moisture had a significant effect on bean yield. Bean yields were in general higher at Moro (after fallow) than at Pendleton (recrop) in this year. In 2003, precipitation was probably adequate for annual cropping at Pendleton.

CBARC, Pendleton

Bean yield: In 2002, the *desi* chickpea, 'Myles', produced the highest yield, followed by 'CA99901604W' (Fig. 1). Bean yields from the other varieties were not significantly different from each other and were about 600 lbs/acre lower than the yield of 'Myles'. Despite being grown following wheat in a drought year, 'Myles' produced more than twice the yield of the other varieties. The reasons for the differences in bean yield between 'Myles' and the other varieties were not so apparent. Plant density did not influence bean yields since there were no significant differences in plant counts among the varieties (Table 1). There were some significant differences in plant height among the varieties (Table 1). Bean yields, however, were not significantly correlated (r = -0.28) with plant height. Disease incidences involving combinations of *Fusarium solani, F. oxysporum*, the bean leafroll, and alfalfa mosaic viruses (Table 1) appear to have influenced bean yields. 'Myles' and 'Sanford' were less affected by disease than the other varieties. Disease, however, only explained about 18 percent (r = -0.42) of yield variation, indicating that there were other factors with greater influence on bean yield. 'Myles' matured about 12 days earlier (in July) than other varieties and probably avoided increasing drought stress experienced in August when the other varieties matured. It is also probable that 'Myles' produced the highest yields through drought resistance.

In 2003, 'Sinaloa' and 'Myles' produced the highest yields (Fig. 2). The yields of the other varieties were not significantly different from each other. Yield was not significantly correlated to either plant stand (r = 0.23) or plant height (r = -0.21). 'Myles' and 'Sinaloa', which produced the highest yields, reached maturity earlier than the other varieties (Table 1). This indicates that there could be a yield advantage in maturing before drought and heat stresses increase. Disease incidences were not as high as in 2002 and were not recorded.

Insert Figures 1. and 2.
Insert Table 1

Bean size: Although the *desi* chickpea, 'Myles', produced the highest bean yield, its small bean graded as feed in 2002 (Fig. 3). It is, therefore, a low value crop that has few markets in the United States. A huge market, however, exists in India, Parkistan, and North Africa where the beans are used in a variety of dishes (Saxena and Singh 1987, Singh and Saxena 1999). Of the *kabuli* chickpeas, 'Sinaloa' was the only variety that produced >80 percent grade A beans in 2002 (Fig. 3). The breeding line 'CA99901604W' and 'Sierra' produced about 60 and 65 percent grade A beans, respectively (Fig. 3). The rest of the varieties had lower percentages of grade A beans (Fig. 3). This was probably due to drought stress caused by low 2002 crop-year rainfall coupled with low soil moisture conditions created by the previous wheat crop. Among the *kabuli* chickpeas, grain size of 'Sinaloa' was least affected by low soil moisture. In 2003, a wetter year, 'Dwelley', 'Sinaloa', and 'CA99901604W' produced beans that were >80 percent grade A (Fig. 4). The remaining three *kabuli* varieties averaged 70 to 80 percent grade A beans (Fig. 4). 'Myles', the *desi* variety, produced mostly grade C and feed-grade beans (Fig. 4).

Insert Figure 3
Insert Figure 4

CBARC, Moro
Bean Yield: As at Pendleton, 'Myles' produced the highest bean yields at Moro in 2002 (Fig. 5). The yields of the rest of the varieties were not significantly different from each other and were about 200 to 300 lbs/acre lower than the yield of 'Myles'. The bean yields of the *kabuli* varieties were about 200 lbs/acre higher than at Pendleton, probably because they were grown on previously fallow land at Moro. Plant stand, plant height, and disease (Table 2) were not significantly different among varieties and consequently these parameters cannot explain differences in bean yields. 'Myles' matured about 8 days earlier than other varieties and could have escaped increasing drought conditions experienced at the end of the season. In 2003, bean yields were not significantly different

among all the varieties (Fig. 6). 'Dwelley', however, produced the highest yield, followed by 'Myles'. Once more, plant stand and height were not significantly correlated with bean yield.

Insert Figure 5
Insert Figure 6
Insert Table 2

Bean size: At Moro, beans produced by 'Myles', the *desi* chickpea, were too small to be classified as grade A or B in both years. The beans were classified as feed or grade C (Figs. 7, 8). In contrast to Pendleton, all the *kabuli* chickpeas produced >80 percent grade A beans at Moro in 2002 (Fig.7). This was probably because there was enough moisture following fallow to minimize drought stress. In 2003, all *kabuli* varieties except 'Evans' and Sanford' produced >80 percent grade A beans (Fig. 8). 'Sinaloa' produced the highest percent of grade A beans during this year.

Insert Figure 7
Insert Figure 8

Variety adaptability
To determine the overall adaptability of the chickpea varieties to eastern Oregon, bean yields and bean size of varieties from the two sites and two years were combined and analyzed for trends using regression analysis.

Bean yield: Figure 9 shows mean yield of each variety compared to the mean yield of all varieties evaluated in each experiment at Moro and Pendleton in 2002 and 2003. The cropping systems practiced at Moro and Pendleton sites coupled with precipitation received created conditions with relatively low and high yield potential. For instance, the effect of fallow at Moro in 2002, a drought year, created growing conditions with high yield potential. In contrast, annual cropping at Pendleton created growing conditions with low yield potential during this year. In 2003, higher precipitation at Pendleton and Moro created growing conditions with high yield potential. Reference to low and high yield potential below, therefore, is not site specific but refers to the growing conditions experienced by the varieties.

'Dwelley' responded poorly under conditions of low yield potential and yielded close to the trial mean under conditions of high yield potential (Fig. 9). Although below the trial mean, 'Sinaloa' responded better under conditions of low yield potential and above the trial mean under conditions of high yield potential (Fig. 9). 'Evans' expressed poor response to both low and high yield potential conditions (Fig. 9). 'Myles' demonstrated wide adaptability to low and high yield potential conditions and maintained similar yield levels under both environments (Fig. 9). 'Sanford' and 'Sierra' represent varieties that responded poorly to low yield potential conditions and produced yield equal to the trial mean under conditions of high yield potential (Fig. 9). 'CA99901604W' yielded above the trial mean under low yield potential conditions and responded poorly under high yield potential conditions (Fig. 9).

Insert Figure 9

Bean size: Profit margins can be increased by producing high yield with a high percentage of grade A beans. A suitable variety, therefore, should posses both attributes. Figure 10 shows the percent of grade A beans for each variety regressed against the mean percent of grade A beans of all the varieties evaluated at Moro and Pendleton in 2002 and 2003. The percentage of grade A beans for 'Dwelley' equaled the trial mean (<50 percent) under low yield potential conditions and was >80 percent under high yield potential conditions (Fig.10). 'Sinaloa' expressed wide adaptability and produced >80 percent grade A beans under both low and high yield potential conditions (Fig. 10). 'Evans' and 'Sanford' responded poorly under low yield potential conditions and slightly above the trial mean under high yield potential conditions (Fig. 10). Being a *desi*, 'Myles' did not produce any grade A beans (Fig. 10). 'Sierra' and 'CA99901604W' responded better than the trial mean under both conditions but the percentage of grade A beans under low yield potential conditions was lower than under high yield potential conditions (Fig. 10).

Insert Figure 10

Conclusions

The *kabuli* varieties produced higher yields and bigger beans when soil moisture was adequate (after fallow and in a wetter year) but most produced lower bean yield and smaller seed when grown following a wheat crop under low rainfall conditions. The *kabuli* chickpeas command premium prices in the United States. 'Sinaloa' appears to be the only *kabuli* that is well adapted to low soil moisture conditions. To obtain both high bean yield and a high percentage of grade A beans under both low and high yield potential conditions, 'Sinaloa' is recommended. The other *kabuli* chickpeas should be grown mostly under high yield potential conditions**.** If bean yield is the only important factor, then the *desi* chickpea, 'Myles', should be grown under both low and high yield potential conditions. 'Myles' produced exceptionally high yields under low yield potential conditions. It appears to be well adapted to the eastern Oregon environment and yields well under both annual and fallow cropping systems. Unfortunately, *desi* chickpeas are small-seeded and are currently low value beans in the United States. However, the potential exists for exporting *desi* chickpeas to India and Pakistan where they are in demand. India alone requires about 700,000 tons a year although it is the world's largest producer. Canada has capitalized on this market and now exports about 220,000 tons annually to the Indian subcontinent.

Acknowledgements

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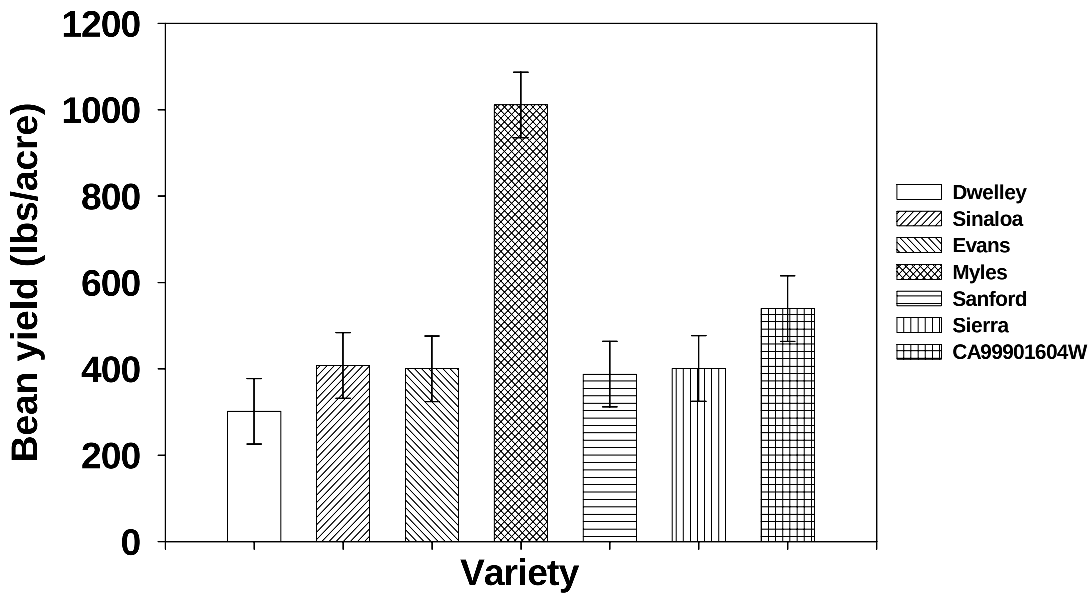


Figure 1. Bean yield of chickpea varieties at CBARC, Pendleton, Oregon, 2002. Bars represent standard error.

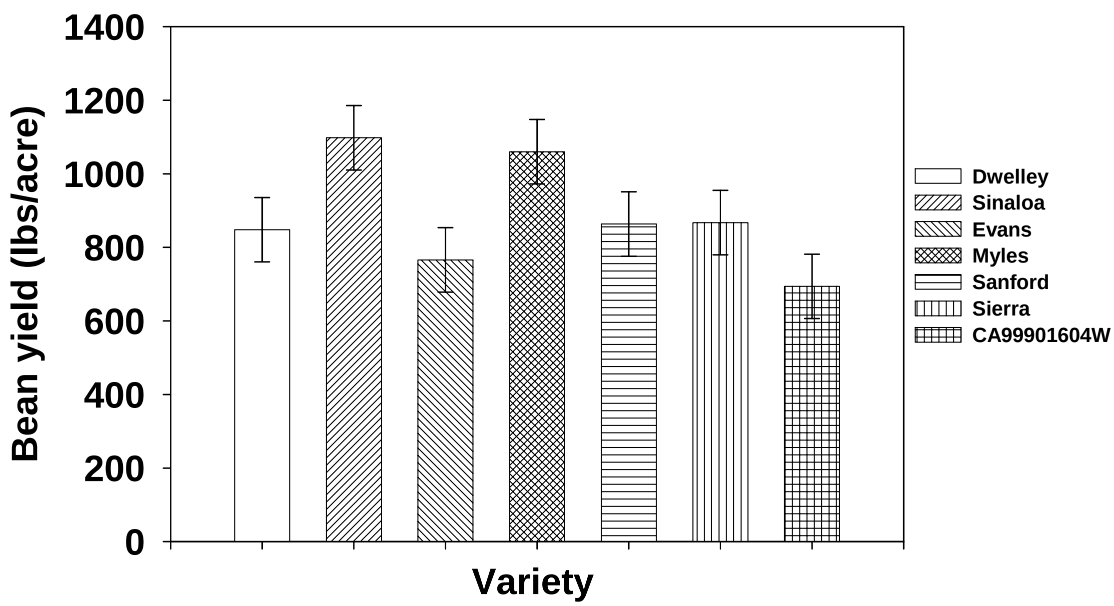


Figure 2. Bean yield of chickpea varieties at CBARC, Pendleton, Oregon, 2003. Bars represent standard error.

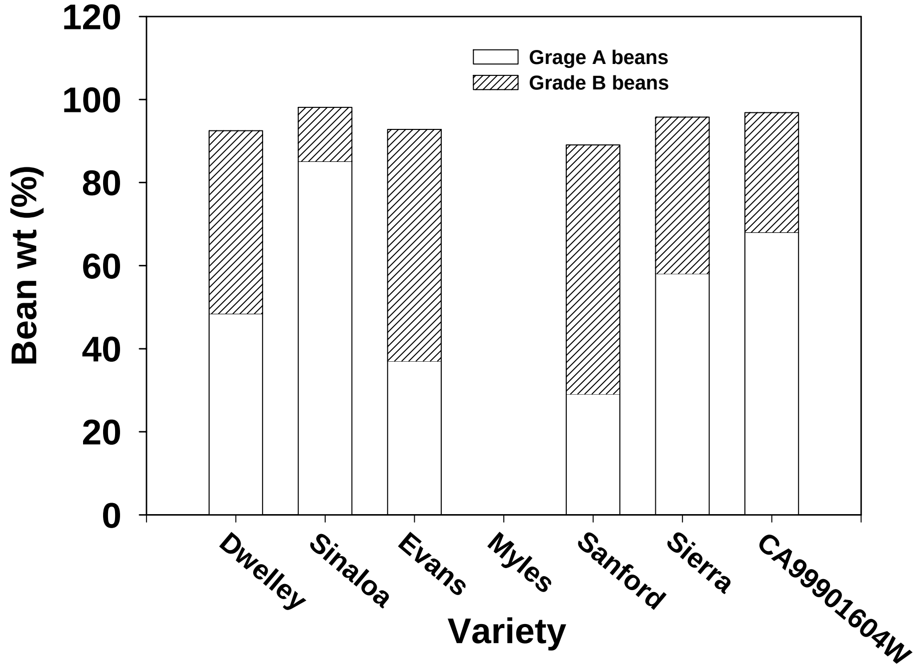


Figure 3. Bean size of chickpea varieties at CBARC, Pendleton, Oregon, 2002.

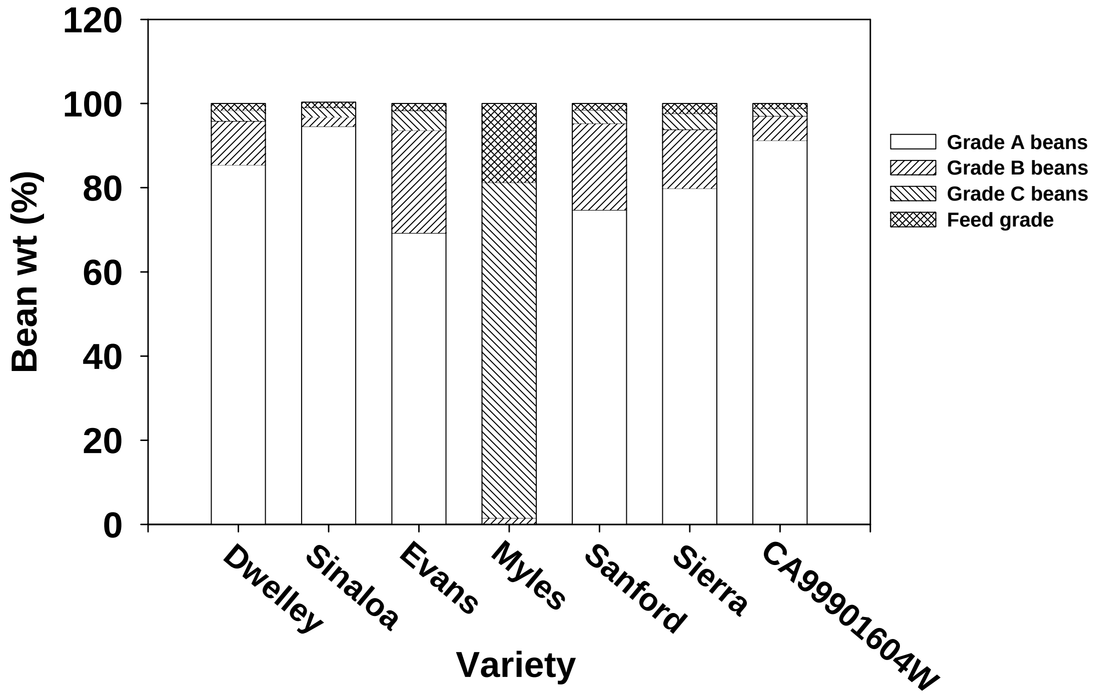


Figure 4. Bean size of chickpea varieties at CBARC, Pendleton, Oregon, 2003.

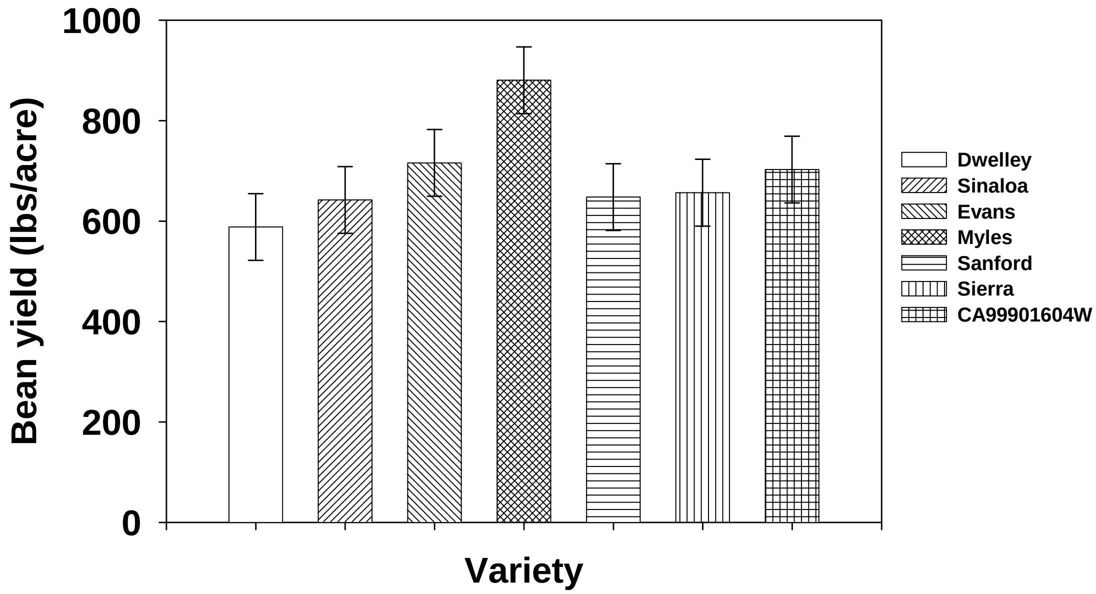


Figure 5. Bean yield of chickpea varieties at CBARC, Moro, Oregon, 2002. Bars represent standard error.

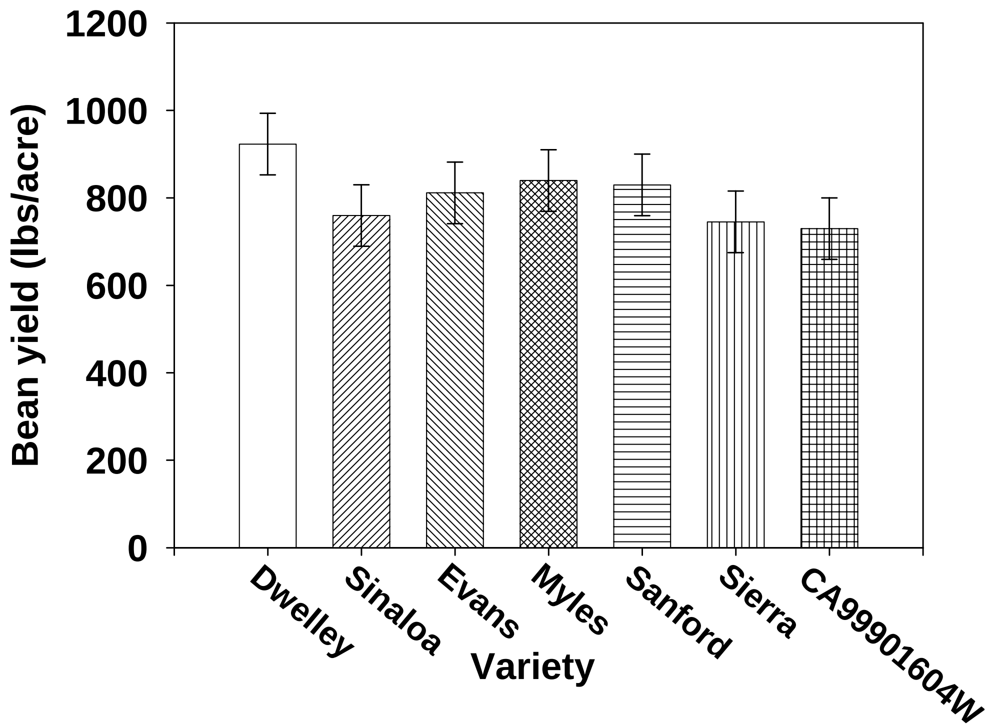


Figure 6. Bean yield of chickpea varieties at CBARC, Moro, Oregon, 2003. Bars represent standard error.

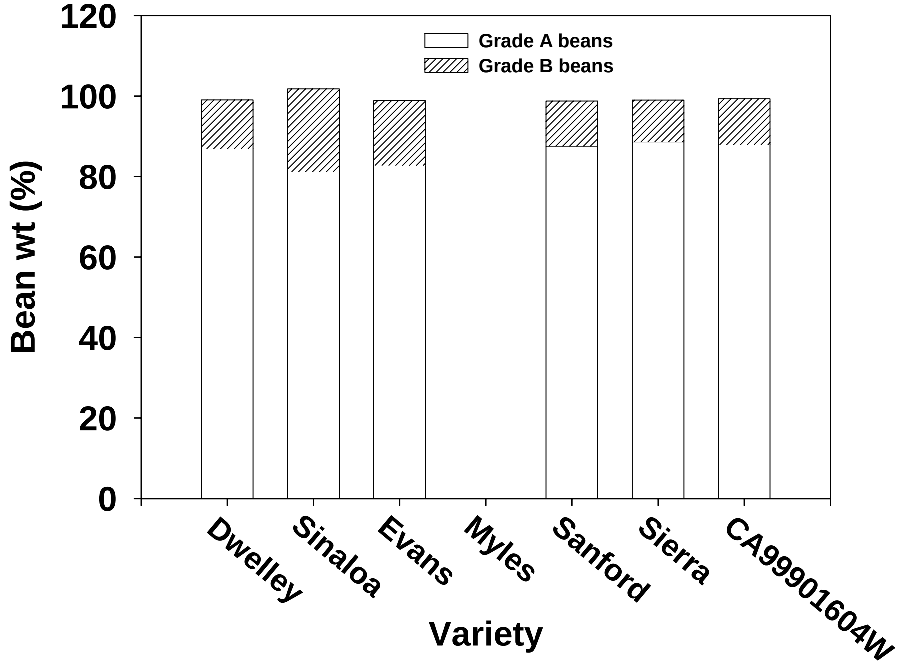


Figure 7. Bean size of chickpea varieties at CBARC, Moro, Oregon, 2002.

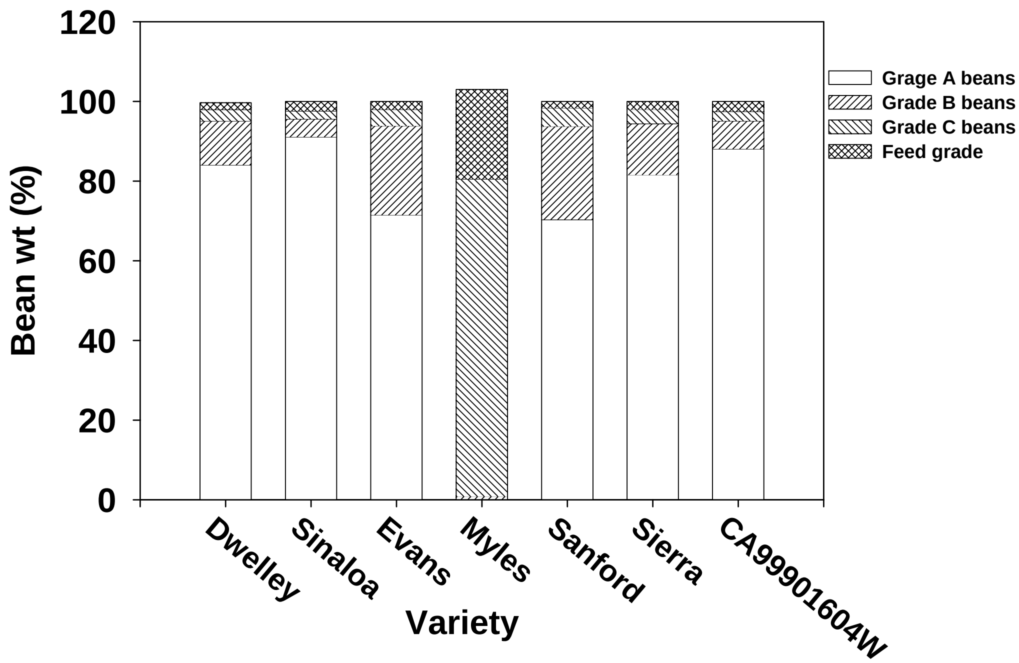
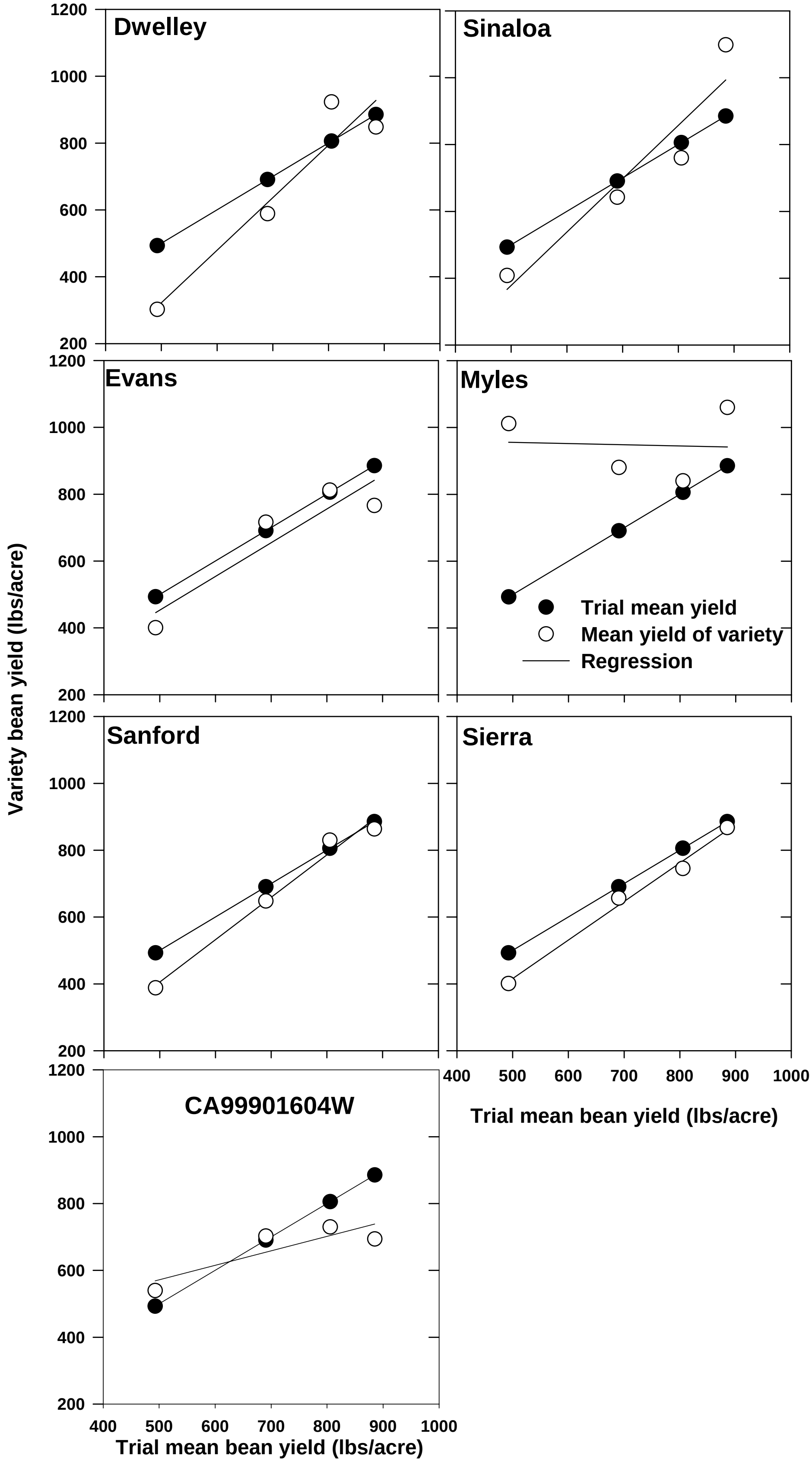


Figure 8. Bean size of chickpea varieties at CBARC, Moro, Oregon, 2003.



Dwelley
Sinaloa
Evans
Myles
Sanford
Sierra
CA99901604W
Trial mean yield
Mean yield of variety
Regression
Variety bean yield (lbs/acre)
Trial mean bean yield (lbs/acre)
Trial mean bean yield (lbs/acre)

Figure 9. Bean yield response of each chickpea variety relative to trial mean bean yield at CBARC, Oregon, 2002-2003.

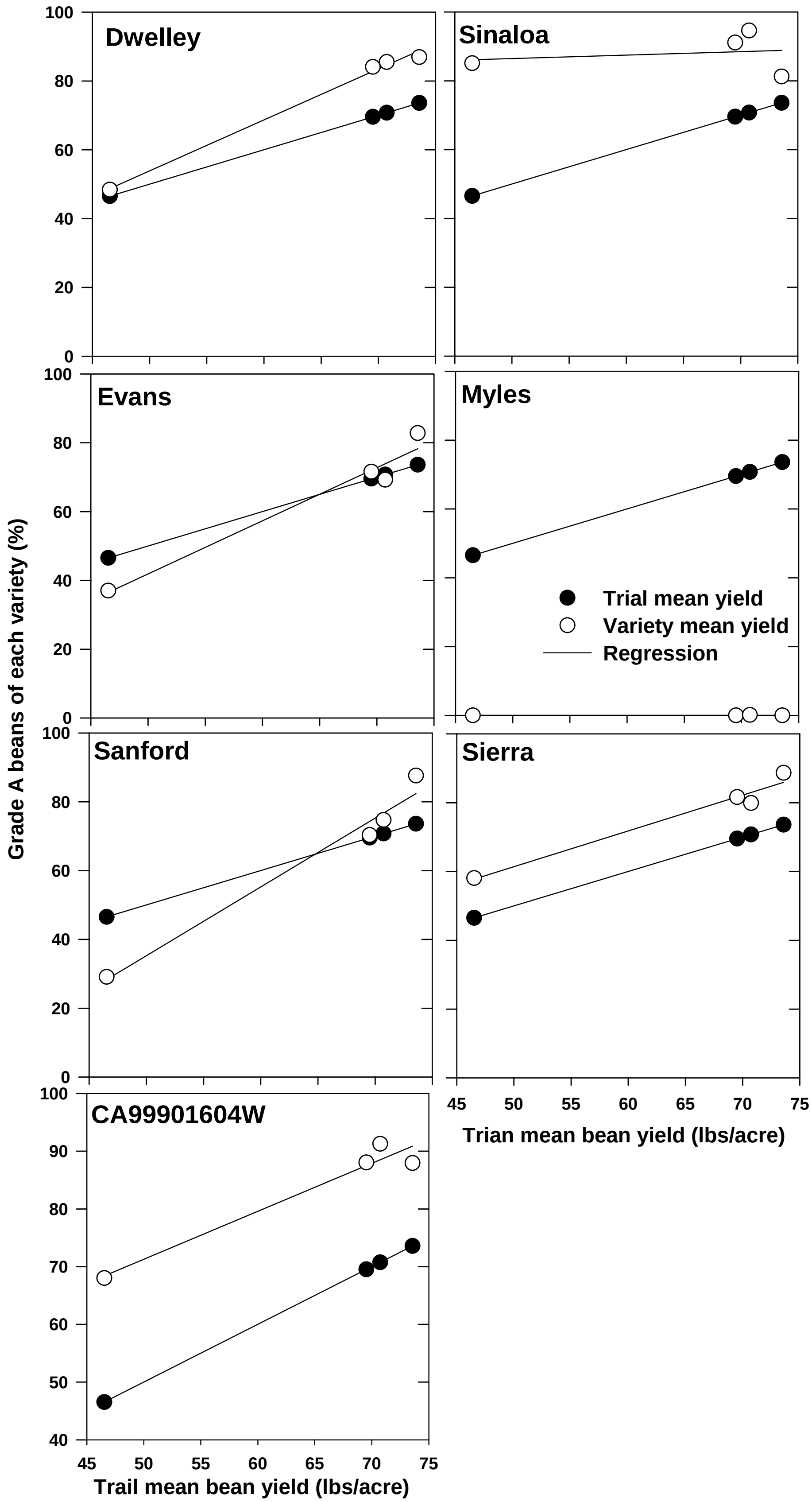

Dwelley
Sinaloa
Evans
Myles
Sanford
Sierra
CA99901604W
Trial mean yield
Variety mean yield
Regression
Grade A beans of each variety (%)
Trail mean bean yield (lbs/acre)
Trian mean bean yield (lbs/acre)

Figure 10. Grade A bean size response of each chickpea variety relative to trial mean grade A bean size at CBARC, Oregon, 2002-2003.

Table 1. Plant stand, height, and disease incidence of different chickpea varieties at CBARC, Pendleton, Oregon, in 2002 and 2003.

	2002			2003		
Variety	Plants/ft^2	Plant ht (in)	Disease (%)	Plants/ft^2	Plant ht (in)	Maturity (days)
Dwelley	3.3a[1]	15.4a	36.3ab	4.1ab	13.1ab	96
Sinaloa	3.1a	11.9c	46.3a	3.8b	13.5ab	90
Evans	3.3a	15.7a	48.8a	3.9ab	12.9b	96
Myles	3.2a	13.6b	12.5d	5.3a	11.3c	84
Sanford	3.5a	15.9a	17.5cd	3.8b	13.4ab	96
Sierra	3.3a	15.9a	27.5cb	3.8b	13.4ab	96
CA99901604W	2.6a	13.0bc	25bcd	3.7b	13.6a	96

[1]same letter indicates that means are not significantly different (P < 0.05).

Table 2. Plant stand, height, and disease incidence of different chickpea varieties at CBARC, Moro, Oregon, in 2002 and 2003.

	2002			2003		
Variety	Plants/ft^2	Plant ht (in)	Disease (%)	Plants/ft^2	Plant ht (in)	Maturity (days)
Dwelley	2.7a[1]	12.3a	26.3a	3.7a	12.3a	106
Sinaloa	2.4a	13.3a	25.0a	3.1a	12.0ab	100
Evans	2.4a	12.8a	28.8a	3.7a	12.0ab	106
Myles	2.8a	11.3a	25.0a	3.9a	11.5b	98
Sanford	2.4a	11.5a	21.3a	3.3a	12.3a	106
Sierra	2.8a	13.3a	21.3a	3.0a	12.5a	106
CA99901604W	2.6a	12.4a	25.0a	2.5a	12.4a	106

[1]same letter indicates that means are not significantly different (P < 0.05).