Yield Performance of Chickpea (*Cicer arietanum* L.) Varieties Across Locations of the Philippines Cordillera Region

Ines C. Gonzales and Fernando R. Gonzales

Abstract

The multi locational yield trials were conducted in three municipalities of Benguet (La Trinidad, Loo Buguias, Pito, Bokod), Langagilang, Abra and Tabuk, Kalinga from October to November 2010. Kabuli type varieties, ICCV 92311, ICCV 95334 and ICCV 07307 were the earliest to reach 50% flowering and harvesting. Plant maturity was generally earlier in warm places like Abra and Kalinga regardless of variety used. Kabuli type varieties are generally taller with wider canopy. Results showed that taller plants with wider canopy are produced in cooler areas of Benguet while short plants with smaller sized canopy was observed in warm areas like in Abra and Kalinga. Desi type ICCV 93952 and kabuli type ICCV 95334, ICCV 07307 had the highest number of pods with more filled pods produced per plant while the number of unfilled pods per plant was not affected by the varieties used across locations. The 100 seed weight was significantly heavier in big-seeded kabuli type ICCV 95334 and ICCV 07307 in all locations. Desi type ICCV 93952 and kabuli type ICCV 95332, ICCV 07307 had the highest grain yield per plot and computed yield per hectare across locations. Generally the yield per plot and computed per ha was higher in colder areas of Benguet than in warmer areas of Abra and Kalinga. Based on the results desi type ICCV 93952 and kabuli type ICCV 95334, ICCV 07307 can be productively grown in Benguet but could also be grown in warmer areas like Apayao and Kalinga but with minimal yield.

Keywords: cordillera, desi, filled pods, kabuli

Rationale

With the increasing prices of the basic commodities, rice, wheat and other food supplements the purchasing power of the allotted budget for every poor family in the Cordillera Administrative Region becomes insignificant.

The country has at least 10 million ha of cultivated land for which only 1.2 million ha is irrigated and 8.8 million ha is rainfed or drylands. Dryland crops will significantly boost livelihood of poor rainfed and upland farmers. Dryland agriculture also helps ensure food and nutritional security for the poor.

The International Crops Research Institute for Semi-Arid Tropics (ICRISAT) is one of the members of the Consultative Group on International Agricultural Research (CGIAR) conducting research work on legumes. One of ICRISAT's crop mandates is chickpea (common name is 'garbansos') which can be grown profitably in CAR specifically in Benguet where cool season prevails, a climatic condition ideal for chickpea production.

Chickpea (*Cicer arietanum* L.) is an annual cool season legume or pulse crop commonly used as a green vegetable. Chickpea has one of the highest nutritional compositions of among any dry edible legume. On an average, chickpea seed contains 23% protein, 47% starch, 56% fat, 6% crude fiber, 6% soluble sugar, and 3% ash (www.ICRISAT.org/chickpea/chickpea.htm).

Chickpea, however, has not been introduced or cultivated in the dryland/rainfed areas of Northern Luzon due to lack of information and available planting materials. With the introduction of new ICRISAT cultivars of chickpea, coupled with the generation of location-specific technologies, chickpea could become a major cash earner.

Chickpea is widely consumed in the Philippines and the demand is widely met through import from countries like India, Turkey, Pakistan, Iran, Mexico, Australia, and Canada (Mula et. al., 2011). On the average, the Philippines imported 735 tons of chickpea (valued at $US442,000) per year during the past decade. The average wholesale price of chickpea ranges from $US0.60-1.20/kg, while the average global productivity continues to be low at 700-800 kg/ha, mainly because chickpea is generally grown under rainfed condition.

Initial findings of chickpea production in Benguet by Gonzales et. al. (2007), however, showed that the yield potential of this crop is higher at 800-1,200 kg/ha than the global production (700-800 kg/ha). This only shows that chickpea production in CAR can compete with the global production especially with the use of the best adaptable varieties and location-specific technologies.

Aside from being an alternative high value crop for CAR farmers as source of livelihood, chickpea can also serve as an additional or supplemental source of protein. Because of its nitrogen fixing ability, it also has a potential use for green manure to improve soil fertility. Moreover, chickpea can also serve as a rotation crop to help rest the soil from the usual crops grown in CAR. It can easily fit to a cropping pattern such as crucifers-chickpea-potato, or rice-chickpea-corn, or other combinations that the farmers may see fit for them.

Review of Literature

Chickpea (*Cicer arietanum* L.) is a small annual plant. It approximately grows 30-60 cm tall. The root system is well-developed, and usually includes a strong central tap root with numerous lateral branches that spread out in all directions at the upper layer of the soil. The stem, generally grayish in appearance, is branched with one terminal leaflet. However, the number usually 9 to 15 pairs, as well as the size of leaflet varied. The leaflets of pinnate leaves are small and have serrated edges. The leaves also vary in color, some being light green while others are green or dark green. Certain types possess leaflets with red margins. The flowers are typically pappilionaceous, consisting of five petals and sepals, the standard, two wings and two keels, ten stamens, and a carpel with the style borne laterally on the ovary. The pod is about 2 cm

long and usually contains two seeds. A single plant produces about 50 to 150 pods. Seeds are spherical in shape, wrinkled and with a pointed beak. The seeds vary in size as well as in color, from white, light brown, yellowish orange, dark brownish and with a little bluish tinge. The seed coat may be smooth or puckered or wrinkled. The cotyledons are thick and yellowish in color (Singh, 1983).

There are two main types of chickpea - the 'Desi' with high fiber, and the 'Kabuli' with lower fiber content. Both types contain approximately 20 to 24% crude protein of high quality. Chickpea contains low levels of trypsin inhibitors and possibly other nutritional factors. The market price of chickpea is generally decided by the appearance (size, shape and colour) of the grain. 'Kabuli' chickpea is generally used as whole grain and most 'desi' are used in making splits (dhal) and flour (besan), so the preferred seed traits for these two types of chickpea vary considerably. Most markets prefer small to medium 'desi' seeds (16-22 g 100 seedweight) and pay modest premiums for the large grades. There is preference for 'desi' type with yellow to light brown seedcoat color, and small niche markets exist for green and black seeded 'desi' type. More than 70% of 'desi' chickpea is used for making dhal and a portion is processed into flour (besan). High milling efficiency (dhal recovery) is therefore an important trait. On the other hand, seed size is the most important trait for 'kabuli' type chickpea. In general, larger seeds get high premium price. There is generally a preference for white or beige seedcoat and ram's head seed shape. As the bulk of 'kabuli' chickpea is cooked as whole grain, cooking time and seed volume expansion (on soaking) are considered important quality traits (Yadav et. al., 2007).

Chickpea is a cool season annual crop performing optimally at 21.1 to 26.7^{o}C daytime temperature and 17.8 to 21.170^{o}C night temperature. They produce good yield in drier conditions because of their deep tap root. Heavier rainfall seasons show reduced yield due to disease outbreaks and stem lodging resulting from the excessive growth. An area with a well-distributed rainfall pattern produces the highest yield and quality of chickpea seeds. Chickpea requires heavy soils. Irrigation was done at branching and at pod initiation stage gave better yield. Moisture stress in the early stage results in low and non-uniform stands, stunted plants, reduced branching, and pale-colored lower leaves (Martin et al., 1976).

Gonzales et al., 2008 in an initial study on chickpea in Benguet showed that 'kabuli' type had 54% pod setting while 'desi' type had 57%. Occurrence of fog with long cloudy condition and very close planting distance reduced pod setting and mean seed yield/plant. Total seed yield showed that 'desi' type varieties had lower yield (800 to 900 kg/ha) than 'kabuli' type (1,000 to 1,200 kg/ha).

Objectives:

1.To determine the adaptability of chickpea in the Cordillera Administrative Region.
2.To evaluate yield potential of chickpea varieties across locations in CAR.
3.To determine the variety of chickpea that would produce the highest grain yield across locations

Methodology:

Selected outstanding lowland and highland entries from activity 1 (Germplasm collection, Evaluation of thirty collections) was further tested through multi location yield trials. The trials was conducted in three lowland and three upland areas in the Cordillera Administrative Region (CAR) following the Package of Technology (POT) developed following the rate of fertilizer of 2.5 t/ha of sagana 100 plus 200 kgs/ha of triple 14 as basal application and 2.5 t/ha of triple 14 at hilling-up. Irrigation was done once a week. Spraying with insecticide and fungicide was done to control pod borer, leaf miner and fusarium rot. Rodents were controlled by applying zinc phosphide.

Five desi type varieties; ICCV 93954, ICCV 10, ICCV 93952, ICCV 06102 and ICCV 07114 and three kabuli type varieties; ICCV 92311, ICCV 95334, ICCV 07307 were planted in 1.2m x 5m plot with four rows having a planting distance of 30 cm x 10 cm (lowland) or 30 cm x 20 cm (highland) between rows and hills. The trials across locations were replicated four times, and laid out following Randomized Complete Block Design (RCBD). The data was analyzed using the Duncans' Multiple Range test (DMRT) at 5% level.

The multi-locational trial was conducted twice, on October 2009-January 2010 for first planting and January-April 2010 for the second planting. The three highland areas was coordinated by the various campuses of Benguet State University (BSU), namely BSU Main Campus, Loo, Buguias and Ambangeg, Daclan, Bokod. The elevation in Benguet ranged from 1,210 to 1,265 masl. The lowland areas had an elevation ranging from 500-700 masl, and the trial was conducted in coordination with the following State Universities and Colleges (SUC) in Cordillera Administrative Region (CAR), Kalinga State Agricultural College (KSAC) and Abra State Institute of Science and Technology (ASIST).

Results and Discussions

Number of days from planting to 50% flowering across locations

The number of days from planting to flowering was significantly affected by the varieties used. Results showed that kabuli type varieties ICCV 92311, ICCV 95334 and ICCV 07307 significantly attained flowering earlier than the desi type varieties across locations (Table 1). It was observed that the different varieties tested flowered earlier in warm areas like in Abra and Kalinga while flowering was delayed in cool areas like Benguet.

Nevertheless, the number of days from planting to flowering in cool areas ranged from 51.25 days to 66.00 days while in warm areas, flowering ranges from 39.00 days to 51.75 days.

TABLE 1
Number of days from planting to flowering across locations

Variety	BENGUET			ABRA*	KALINGA*
	La Trinidad	Bokod	Buguias		
Desi-type	65.00 a	64.25 a	63.75a		
ICCV 93954/ ICCV 10*				47.50a	51.50a
ICCV 93952	66.00a	64.75a	64.25a	51.50a	51.25a
ICCV 06102 ICCV 07114*	64.75a	63.50a	64.50a	49.50a	51.75a

Kabuli-type ICCV 92311	61.25b	51.25b	54.25c	43.50b	48.75b
ICCV 95334	61.00b	52.75b	53.75c	39.00b	47.25b
ICCV 07307	61.25b	53.25b	58.00b	40.50b	47.75b
CV(%)	3.11	4.73	2.84	2.37	2.40

Means of the same letters are not significantly different at 5% level DMRT

Number of days from planting to harvesting across locations

The effect of the different varieties used across locations on the number of days from planting to harvesting was significant (Table 2). Results showed that Kabuli type cultivars ICCV 92311, ICCV 95334 and ICCV 07307 were significantly harvested earlier across locations than desi-type cultivars. Chickpea planted in Abra regardless of variety were harvested the earliest due to warm conditions during the pod development and maturity stage. Results showed further that temperature had a very important role in chickpea production where flowering and maturity is directly affected.

Results further showed that in warm areas like Abra and Kalinga, Kabuli type ICCV 95334 and ICCV 07307 were harvested earlier than desi type ICCV 93952 while ICCV 07114 were the latest to be harvested. On the otherhand under Benguet conditions, ICCV 07307 planted in Bokod were harvested earlier while ICCV 93954 planted in La Trinidad were harvested the latest.

TABLE 2
Number of days from planting to flowering across location

Variety	BENGUET			ABRA*	KALINGA*
	La Trinidad	Bokod	Buguias		
Desi-type ICCV 93954/ ICCV 10*	158.00 a	139.25 a	147.75b	115.50a	114.75b
ICCV 93952	148.00b	127.00 bcd	146.00bc	104.50b	120.75a
ICCV 06102/ ICCV 07114*	154.75a	131.75b	153.75a	117.00a	114.75b
Kabuli-type ICCV 92311	138.75c	130.50bc	142.00cd	97.50c	112.25d
ICCV 95334	137.35c	124.00cb	138.00d	96.50d	113.25cb
ICCV 07307	137.25c	123.25d	139.75d	98.00a	110.00d
CV(%)	1.86	3.36	2.19	4.10	1.10

Means of the same letters are not significantly different at 5% level DMRT

Plant height at maturity across locations

The plant height at maturity was significantly affected by the different varieties used across locations (Table 3). Kabuli type varieties were significantly taller than desi type in all locations. Results showed that chickpea planted in warm areas (Abra and Kalinga) were shorter compared to those plants planted in Benguet. It was observed that Kabuli type ICCV 95334 was the tallest at harvesting while the shortest was ICCV 93952. Results further showed that plants planted in La Trinidad, Benguet were the tallest at harvesting due to cooler temperatures and high relative humidity during the growing season that initiated continuous growth.

TABLE 3
Plant height at maturity (cm) across location

Variety	BENGUET			ABRA*	KALINGA*
	La Trinidad	Bokod	Buguias		
Desi-type ICCV 93954/ ICCV 10*	83.25 b	43.68c	57.10b	39.68bc	37.93a
ICCV 93952	80.15b	44.27c	59.45b	37.18c	35.30a
ICCV 06102 ICCV 07114*	81.35b	45.35bc	58.80b	38.92c	36.98a
Kabuli-type ICCV 92311	88.60a	50.27b	84.60a	44.18b	44.58b
ICCV 95334	91.30a	55.37a	90.20a	47.68a	46.90b
ICCV 07307	87.60a	55.48a	85.07a	45.12b	45.95b
CV(%)	6.59	3.25	7.60	3.25	2.88

Means of the same letters are not significantly different at 5% level DMRT

Plant canopy at maturity across locations

Plant canopy was significantly affected by different varieties used in some locations. Under Benguet conditions, chickpea planted in La Trinidad had the widest canopy cover followed by those planted in Buguias, Benguet while comparable plant canopy at maturity was observed in Abra and Kalinga. It was further observed that kabuli type varieties had significantly wider plant canopy at maturity compared to desi type varieties used (Table 4). Results further showed that taller plants generally had wider plant canopy than shorter plants.

TABLE 4
Plant canopy at maturity (cm) across location

Variety	BENGUET			ABRA*	KALINGA*
	La Trinidad	Bokod	Buguias		
Desi-type ICCV 93954/ ICCV 10*	87.55a	44.40a	64.80b	31.17c	30.85d
ICCV 93952	86.30a	43.88a	61.90b	38.88b	31.93cd
ICCV 06102 ICCV 07114*	83.25a	44.00a	67.87b	37.01b	33.23c
Kabuli-type ICCV 92311	82.25a	45.65a	77.20a	40.23a	46.75a
ICCV 95334	90.35a	49.50a	80.40a	44.25a	43.25b
ICCV 07307	91.35a	46.25a	78.80a	43.75a	45.50a
CV (%)	19.32	9.46	11.75	7.41	3.62

Means of the same letters are not significantly different at 5% level DMRT

Grain yield per plot (g) across locations

The different varieties used significantly affected the grain yield per plot across locations (Table 5). It was observed that grain yield per plot was generally higher under Benguet conditions than in Abra and Kalinga conditions. Results showed that desi type ICCV 93952 and kabuli type varieties ICCV 95334 and ICCV 07307 had significantly the highest grain yield per plot across locations while kabuli type ICCV 92311 had the least yield per plot. Results further showed that chickpea planted under La Trinidad regardless of cultivar had the highest yield per plot followed by the plants planted under Buguias, Benguet conditions.

TABLE 5
Grain yield per plot (g) across location

Variety	BENGUET			ABRA*	KALINGA*
	La Trinidad	Bokod	Buguias		
Desi-type ICCV 93954/ ICCV10*	1285.55b	1056.25ab	1256.30b	788.00c	655.00b
ICCV 93952	1617.66a	1134.50a	1585.80b	1028.50a	820.00a
ICCV 06102 ICCV 07114*	1221.93b	1057.50ab	1098.50c	859.50b	655.00b
Kabuli-type ICCV 92311	1180.03c	991.75c	987.30c	752.50c	626.00b
ICCV 95334	1627.50a	1020.25b	1545.80a	1057.75a	798.00a
ICCV 07307	1623.44a	1028.12b	1417.50a	1417.50a	776.00a
CV(%)	8.03	9.23	13.13	7.31	5.92

Means of the same letters are not significantly different at 5% level DMRT

Average number of pods per plant across locations

The average number of pods produced per plant as affected by varieties used differed significantly across location. Generally, chickpea grown in warm area has lower number of pods per plant while those grown in cooler areas had more pods produced per plant regardless of variety.

Results showed that desi type ICCV 93952 had the highest number of pods produced per plant across locations while kabuli type ICCV 92311 and desi type ICCV 93959 and ICCV 10 had the least.

TABLE 6
Average number of pods produced per plant across location

Variety	BENGUET			ABRA*	KALINGA*
	La Trinidad	Bokod	Buguias		
Desi-type ICCV 93954/ ICCV 10*	106.83d	87.60 c	102.45c	67.75c	45.78c
ICCV 93952	174.53a	132.28a	180.25a	87.25a	66.35a
ICCV 06102 ICCV 07114*	158.55b	107.08b	128.15b	73.25b	65.68ab
Kabuli-type ICCV 92311	135.18c	84.28c	83.40c	62.25c	47.35c
ICCV 95334	142.85c	107.43b	139.15b	70.25b	57.60b
ICCV 07307	151.65b	950.10c	140.45b	81.50ab	69.73a
CV(%)	14.20	19.47	8.50	15.22	12.17

Average number of filled pods per plant across locations

Significant difference was observed on the number of filled pods per plant as affected by varieties used. Results showed that desi type ICCV 93952 had the highest number of filled pods produced per plant across location followed by Kabuli type ICCV 95334 and ICCV 07307. Desi type ICCV 93954, ICCV 10 and kabuli type ICCV 92311 had the least number of filled pods produced in all locations since the total number of pods produced is also minimal.

TABLE 7
Average number of filled pods produced per plant across location

Variety	BENGUET			ABRA*	KALINGA*
	La Trinidad	Bokod	Buguias		
Desi-type ICCV 93954/ ICCV 10*	95.33d	78.47d	92.72c	50.62c	30.91c
ICCV 93952	155.98a	115.78a	159.08a	64.58a	57.98a
ICCV 06102 ICCV 07114*	144.13a	93.16b	111.02cb	57.02b	49.56b
Kabuli-type ICCV 92311	113.53c	71.61e	70.20d	49.68c	38.22c
ICCV 95334	118.73c	89.30cd	119.30b	60.38b	49.93b
ICCV 07307	132.03b	79.83d	122.90b	70.07a	60.46a
CV(%)	16.64	19.34	18.14	21.18	14.26

Means of the same letters are not significantly different at 5% level DMRT

Average number of unfilled pods produced per plant across locations

The average number of unfilled pods produced per plant was significantly affected by the varieties used across location. Desi type variety ICCV 93952 had the highest unfilled pods produced in all locations which ranged from 16.50 to 22.67 unfilled pods per plant except in La Trinidad, Benguet conditions. Results further showed that Kabuli type varieties had more unfilled pods under Benguet conditions while desi type produced lesser unfilled pods when grown in warmer areas.

100 seed weight (g) as affected by variety across locations

Significant differences was observed on the 100 seed weight (g) as affected by different varieties used. Kabuli type varieties has generally heavier seed weight than desi type varieties due to their characteristics as big seeded variety. ICCV 07307 significantly had the heaviest 100 seed weight across locations ranging from 28.12 g to 35.10 g followed by ICCV 95334 with range of 24.65 to 31.92 g. It showed that regardless of varieties, chickpea produced bigger sized seeds in colder areas of Benguet while smaller sized are produced in areas with higher temperatures.

TABLE 9
100 seed weight as affected by variety per plant across location (g)

Variety	BENGUET	ABRA*	KALINGA*

	La Trinidad	Bokod	Buguias		
Desi-type					
ICCV 93954/ ICCV 10*	21.10d	21.79c	20.85d	21.53c	20.75b
ICCV 93952	22.51d	23.10c	22.14c	22.32bc	21.75bc
ICCV 06102 ICCV 07114*	22.15d	21.96c	19.65d	19.72c	18.35c
Kabuli-type					
ICCV 92311	25.30c	23.46c	22.80c	23.10b	22.10b
ICCV 95334	31.92b	30.85b	29.67b	25.30b	24.65b
ICCV 07307	34.88a	35.10a	33.38a	29.33a	28.12a
CV(%)	6.40	8.24	6.98	8.16	9.76

Means of the same letters are not significantly different at 5% level DMRT

Computed yield per ha as affected by variety across locations

Significant results was noted on the computed yield per ha as affected by variety across location. Results showed that desi type ICCV 93952, kabuli-type varieties ICCV 95334 and ICCV 07307 had significantly had higher computed yield per ha while desi type varieties; ICCV 06102, ICCV 07114 and Kabuli type ICCV 92311 had the lowest computed yield in all locations.

It was proven that chickpea could be productively grown in colder areas like Benguet while it could also be grown in areas with warm temperatures but with minimal yield.

TABLE 10
Computed yield per hectare (kgs) as affected by variety across locations

Variety	BENGUET			ABRA*	KALINGA*
	La Trinidad	Bokod	Buguias		
Desi-type					
ICCV 93954 ICCV 10*	1714.07b	1408.33ab	1675.06c	1050.66c	873.33b
ICCV 93952	**2156.87a**	**1512.66b**	**2114.39a**	**1638.00a**	**1093.33a**
ICCV 06102 ICCV 07114*	1627.99bc	1410.00ab	1879.99b	1279.00b	873.33b
Kabuli-type					
ICCV 92311	1627.99bc	1410.00ab	1879.99b	1279.00b	873.33b
ICCV 95334	2169.99a	1360.33ab	2061.06a	1410.33b	1026.44a
ICCV 07307	2164.58a	1273.33b	1889.99b	1340.83b	1034.88a
CV(%)	8.03	5.92	6.06	10.20	12.30

Means of the same letters are not significantly different at 5% level DMRT

Summary and Conclusions

The multi locational yield trials was conducted in three locations of Benguet; Balili, La Trinidad, Loo, Buguias, Pito Bokod; Langagilang, Abra, and Tabuk, Kalinga which was planted from October 2009 to November 2010. Results showed that kabuli type varieties; ICCV 92311, ICCV 95334 and ICCV 07307 were the earliest to reach 50% flowering and harvesting. Plant maturity was generally earlier in warm places like Abra, and Kalinga regardless of variety used. Kabuli type varieties are generally taller with wider canopy. It showed that taller plants with wider canopy was produced in cooler areas of Benguet while shorter plants with smaller sized canopy was observed in warmer areas. Desi type ICCV 93952 and Kabuli type varieties; ICCV 95334, ICCV 07307 had the highest number of pods, filled pods per plant and the number of unfilled pods per plant was not affected by the varieties used across locations. The 100 seed weight was significantly heavier in big-seeded kabuli type ICCV 95334 and ICCV 07307 in all locations. Bigger sized seeds are produced in colder areas of Benguet than in warmer areas of Abra and Kalinga. Desi type ICCV 93952 and kabuli type ICCV 95332, ICCV 07307 had the highest grain yield per plot and computed yield per hectare across locations. Generally the yield per plot and computed per ha was higher in colder areas of Benguet than in warmer areas of Abra and Kalinga.

Recommendations

Based on the results desi type ICCV 93952 and Kabuli type ICCV 95334, ICCV 07307 can be productively grown in Benguet but could also be grown in warmer areas like Apayao and Kalinga but with minimal yield.

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