BIBLIOGRAPHY

ALIDES, FELICIDAD D. MAY 2008. Growth and Yield Performance of Six Chickpea (*Cicer arietinum* L.) Varieties Under Bobok-Bisal, Bokod, Benguet Condition.Benguet State University, La Trinidad, Benguet.

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ABSTRACT

The study was conducted from November 2007 to March 2008 at Bobok-Bisal, Bokod, Benguet to determine the growth and yield performance of chickpea under Bobok-Bisal, Bokod, Benguet condition and to evaluate chickpea varieties that could be productively grown in Bobok-Bisal, Bokod, Benguet.

The growth performance of chickpea under Bobok-Bisal condition had varying growth and yield performance due to differences in seed characteristics as well as the varieties. The growth response of desi type chickpea significantly attains the highest percentage field emergence over the kabuli type varieties. However, earlier duration to flowering of these chickpea was observed in kabuli type particularly ICCV 2, while the desi type attained longer duration. On pod setting, desi type ICCV 94954 had highest percentage while kabuli type ICCV 95334 had the least pod set.

In yield, ICCV 95332 a Kabuli type variety have significantly attained the highest yield per plot and computed yield per hectare compared to ICCV 95334. As to seed quality, kabuli types were observed to produce larger seed size while desi type produced small seeds. Weight of seeds also differs significantly depending on the seed size. Larger seed (ICCV 95334) significantly outweighed the small seeded chickpea particularly desi types varieties including the ICCV 2 kabuli type.

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INTRODUCTION

Chickpea belongs to the family Leguminosae, it is an annual cool season legume and an ancient crop that has been grown in India, the Middle East and parts of Africa for many years. It has also been grown in Turkey nearly 7,400 years ago. The name chickpea was derived ultimately from the Latin name cicer through the French chiche. Garbanzo bean known as kabuli type chickpea comes from the Spanish language while Bengal grams are termed for desi types. About 80% to 90% of the worlds chickpea production comes from India where poor soil, use of unimproved varieties and low results in yield averaging about 700 lb/acre.

Bokod is one of the municipality of Benguet located on the mideastern part of the province, generally mountainous peaks, hill, arrow valleys and a few sloping area with an elevation ranging from 2,000 to 3,150 meter above sea level. It is the second largest municipalities of Benguet having a land total area of 48,830 hectares and 1,567 hectares is devoted for agriculture. Palay and leafy vegetables are considered major commodities in the municipality, wherein four hundred thirty five hectares (435has) is devoted for rice while one thousand thirty nine hectares (1,039 has) is for fruit land and vegetable area.

Bokod belongs to type 1 classification of climate characterized by wet and dry seasons. Dry seasons begin in November and ends in April. Hottest period are in the months of April and May, having a maximum temperature of 27^{o}C. The rest of the year is wet or rainy season. The coldest months are in December, January and February with temperature as low as 12^{o}C with an average temperature of 18 to 20^{o}C. Due to this cool climate condition, chickpea production is acceptably ideal in this locality.

Chickpea has not been introduced or cultivated in the Cordilleras specifically in Benguet even the agro climatic condition provides suitable growth for its production. Seeds are not locally produced due to lack of information for farmers and the non-availability of planting materials to be used. Likewise, the difficulty of producing the seeds in the country eventually makes it necessary for us to import seeds from other countries. Top producing countries of chickpea are India, Turkey, Pakistan, Iran, Mexico, Australia, and Canada. Aside from the climate condition, another factor is the method of culture and production administered with the imported seeds which is different and indigenous with what the local farmers do.

Moreover, the imported seeds are mostly hybrid when grown under controlled condition, their performance growth will be different when the seeds are grown in an open field condition. It is in this process where varietals trial is necessary to evaluate the performance of every cultivar in all locations and aspects to determine its adaptability and acceptability to minimize or eliminate waste of money and other inputs and to attain optimum results which will yield to profit.

Thus, these new hybrid chickpea varieties from ICRISAT was introduced in the highlands of the Cordilleras especially in Benguet to sustain domestic demands, increase productivity and income of farmers and alleviate poverty through the introduction and adaptation of this new crop in the Cordillera region.

This study was undertaken to provide relevant information more specifically, the consideration of temperature requirements on the growth production of this crop beneficial to Benguet farmers who are interested to produce chickpea in their farms.

Moreover, this study was conducted to introduce varieties of chickpea that could be productively grown under Bobok-Bisal, Bokod, Benguet condition, and to promote and fast track the adaptation of suitable chickpea varieties in Benguet Province.

Likewise, this study would also serve as a basis and reference for further research and studies pertaining to chickpea production in our locality.

The study was conducted to determine the growth and yield performance or chickpea varieties and to evaluate chickpea that is resistant to certain insect and diseases prevailing under Bobok-Bisak, Bokod, Benguet condition.

The study was conducted at Bobok-Bisal, Bokod, Benguet from November 2007 to March 2008.

REVIEW OF LITERATURE

Description of Chickpea

Chickpea is a sprawling small herbaceous plant with height ranging between 30 to 70 cm, but all types with lesser than 1.0 m in height are cultivated in the erstwhile USSR. The plant is a multiple branched, spreading growth habit annuals ranging from 80 to 140 inches tall. The foliage is covered with glandular hairs which secret high malic and oxalic exudates and is considered important in conferring tolerance to insect pest, such as pod borer. Leaves are pinnately compounded, arranged in an alternate phyllotary, and generally inparipinnate with 11 to 13 leaflets. The leaflets are small, serrated edges being light green to dark green in color. Certain types posses leaflets with red margins. The flowers are auxiliary, solitary, or inflorescence of two or three. They are white, pink, purplish, or blue in color having five petals and sepals. Anthesis starts between 9 am and 10 am and may continue up to 3pm. The flowers remain for 2 days and the flowering process being over early on the second day. Each flower produces a short, pubescent pod which is ¾ to 2 inches long appearing to be inflated. One or two seeds are present in each pod. The seeds come either rough or green in color. This is a definite groove visible between the cotyledons about 2/3 of the way around the seed, with a beak like structure present. The plant has a deep root system which usually include tap root with numerous lateral branches that spreads in the upper layer of soil. It produces nodules common with other nodules efficient in fixing atmospheric nitrogen. Stems are generally grayish in appearance where the main branch usually produces more than one secondary shoot and

branched with granular hairs, but in some types the main branches may produce numerous lateral branches.

Chickpeas are classified into desi or kabuli types based in part in seed size, color and the thickness and shape of the seed coat. Desi types produces smaller seeds size of 1,500 seeds per pounds. The seeds have thick, irregular-shaped seed coat which can range in color from light to tan black kabuli chickpea. Sometimes called "Garbanzo bean" produce small to large seeds (800 seeds/pounds) having a paper thin seed coat. The kabuli types produce seeds with colors range from white to pale cream colored tan, and plants height is generally taller and grown in temperate regions while desi are grown in the semi and tropics.

Importance of Chickpea

Anon. (1997) stated that legumes are the source of proteins and carbohydrates. However, proteins derived from this are incomplete for which they do not contain all the ammo acid needed by the body. For these reasons, they are often eaten with rice which contains amino acid absent in figures. Chickpea is one with the highest nutritional composition of any dry edible legume. On an average, chickpea seeds contains 23% protein, 47% starch, 56% fat, 6% crude fiber, 6% soluble sugar and 30% ash.

Chickpea is consumed as dry pulse crop and as vegetable tamed as sag (fresh green leaves) and chloe (grains), (Singh, 1983). The seeds are sold in the market either canned or dry. Desirable qualities for canning are medium seed size (50.6 to 52.50 grams per 100 seeds), golden color, rough texture, high water intake and a seed coat that does not fracture easily, Stan Murray, Klein- Berger Co, pers commun., cited by Berrada et. al

(1999). According to Martin , Leonard and Stamp(1976), threshed seeds are prepared for food in much the same manner as dried lima beans, while roasted seeds are used as confectionaries, snack and as coffee substitute. It is also ground into flour called as "BESAN" for the preparation of various types of sweets and unlearned bread. Common uses in the United States are in soups, vegetable combinations or as a component of fresh salads in restaurant salad bars.

Chickpea is also known for its medicinal and agricultural importance. Germinated gram seed is recommended for scurvy, green leaves are the source of malic and oxalic acid which is good to cure intestinal disorders and serves also as a good medicine for blood purification.

Pulse crops, besides being rich in protein and some of the essential amino acids, it also enriches the soil through symbolic nitrogen fixation from the atmosphere. Similarly, Singh (1983) added that straw of gram is an excellent fodder for cattle. Husks and bits of dhal (split chickpea without its seed coat) are valuable for cattle feed. However, the herbage is low yield and is to animals.

Importance of Varietal Selection

Varietals evaluation is the process of crop breeding program which provides comparison of promising lines developed by a breeder. It is the first step in the production of crop to be grown. Varieties need to be evaluated for us to find out what variety is most suited in a certain production area.

UPLB (1972) reported that desired characteristics such as earliness, non-sensitivity to photoperiod, resistance to lodging, insects and diseases, high milling

recovery including good cooking and eating qualities are necessary to be considered in the development of new varieties. Its is only through varietals evaluation that a breeder can see the yield, quality, adaptability, insect pests and disease resistance and stress tolerance.

Therefore, it is essential for the farmers to find the most suited variety or strain of some crops and recommended varieties in order to determine whether the variety fits or not suited in this particular conditions and market demands.

Climatic and Soil Requirements

Pursglove (1968) stated that peas require a cool, relatively humid climate with temperature of 55 to 65. Gram peas perform optimally at 70 to 80 daytime temperature and 64 to 70 at night temperature. Heavier rainfall seasons (over 30 in annually) show reduced yields due to disease outbreaks and stem lodging problems from the excessive vegetable growth. Areas with higher and well distributed rainfall patterns (60 to 90 cm per annum) have produced highest yield and quality chickpea seeds.

The plants are best adapted to well drained, sandy and clay loam soils. Peas when planted on dry and light soils remain short while on heavy soils, having high water retention capacity, the vegetative growth is abundant; light becomes limiting and fruiting is retarded. The optimum PH is from 5.5 to 6.5. However, it is not suited to soils having a PH higher than 8.5, Singh (1983).

Field Preparation

Gram is highly sensitive to soil aeration. This imposes a restriction for its cultivation on heavy soils and calls for special care in seedbed preparation. A rough seeded is required for gram. Very fine and compact seedbed is not good for gram. It requires a loose and well aerated seedbed.

Seed and Sowing

The seeds may be sown by seed drill at spacing between 6 in. and 40 in. delivering the chickpea seeds without damage. The seeds should be 8 to 10 cm. deep to utilize available soil moisture for germination while the shallow sown seed is more liable to be damage by wilt at 60 cm. apart.

Fertility and Lime Requirements

Fertility requirements for chickpea are phosphorous, potassium and certain micronutrients which are recommended for other pulse or legume crops. Fertilizer application should be based on soil test level, previous crop and expected yield level.

However, soil with low organic matter and poor nitrogen supply may require nitrogen (20 to 25 kg per hectare) as starter dose which can meet plant requirements before the foundation of nodules. Gram fulfills the major pat of its nitrogen fixation which works effectively from three to four weeks after sowing. If both nitrogen and phosphorous are required to be supplied, then diamond phosphate (18-46-0) at the rate of 100 to 150 kg per hectare should be applied uniformly before the last disking. Reponses

to potassium application have been inconsistent. It is better if all fertilizers are drilled in furrows at a depth of 7 to 10 cm.

Water Management

Gram is mostly sown as a rain fed crop. However, where irrigation facilities are available, give a pre-sowing irrigation. It will ensure proper germination and smooth crop growth. Peas are deep rooting plants and usually benefits most from irrigation at flowering time (increases number of peas and at pod-swelling stage/increase size of peas). A light irrigation should be managed because heavy irrigation is always harmful to gram crop. Excess of irrigation enhances vegetable growth and depresses grain yield.

Weed Control

Gram being a dwarf stature crop suffers severely by infestation of weeds. Hand weeding or interculture with hand hoe after 25 to 30 days of sowing may take care of the weeds. Tribunil (25 kg 800 to 1000 liter of water per hectare) may be used as pre-emergence spray. Hand weeding is always better than herbicides because intercultural operations improve aeration in the soil.

Harvesting and Threshing

Crop becomes ready for harvest 3-7 months from planting when leaves turn reddish to brown and start shedding. Plant are either plucked out by hand or cut using knife. The crop is allowed to dry in sun threshing floor about 5 to 6 days. Thereafter,

threshing is done either by beating the plants with sticks or by trampling under the feet of bullocks.

Drying and Storage

Moisture content should be around10 to 12% to prevent insects and other disease outbreaks in the storage. Because of their relatively large seed sized, chickpea can be dried slightly with ambient temperature air flow trough thin layers in a regular storage bin. Basket made from twisted rice straw, are usually used as storage containers.

Storage system should be careful fumigated before storing chickpea and all storage areas should be regularly monitored to identify potential problems early. A thin coating with vegetable or helps reduce storage damage.

MATERIALS AND METHODS

The materials used in this study were six varieties of chickpea seeds, insecticides, pesticides, fertilizer, measuring tools (verner caliper, foot rule), weighing scale, thermometer and other farm tools and equipments.

The study was conducted at Bobok-Bisal, Bokod, Benguet having temperature range of 15 to 23^{o}C with an elevation of 1,230 meter above sea level. The study was conducted in an area previously planted with peanut and was laid out following the randomized complete block design (RCBD) with six treatments and four replications each.

Each variety was planted in 2 furrows (1m x 10 m) or a total of 500 square meter. The seeds were planted singly at a distance of 30cm between rows and 10cm between hills. Moreover, inorganic fertilizer (14-14-14) were applied evenly and mixed with the soil before sowing the seeds.

The treatments used were as follows:

Treatment	Variety	Type
T_1	ICCV 93952	Desi type
T_2	ICCV 93954	Desi type
T_3	ICCV 94954	Desi type
T_4	ICCV 2	Kabuli Type
T_5	ICCV 95332	Kabuli Type
T_6	ICCV 95334	Kabuli Type

Cultural management practices such as fertilizer application, pest and disease control and irrigation were uniformly employed in all treatments. Irrigation was done at least twice to trice a week during the early vegetative stage however reduce to at least once a week during its flowering stage to ensure optimum growth and yield.

The data gathered were from 20 sample plants selected randomly per treatment.

A. Vegetative Growth

1. Percentage field emergence (%). This was counted 15 days from sowing the seeds using the formula;

$$\text{Percentage emergence (\%)} = \frac{\text{Number of Seed Emerge}}{\text{Number of Seeds Sown}} \times 100$$

2. Days from planting to flowering. This was counted from planting to first production of flowers.

3. Average height at flowering (cm). This was measured from the base up to the tip of the youngest leaf at first flowering stage.

4. Average number of lateral branches at flowering. This was counted during its first flowering stage.

5. Days from planting to first harvest. This was the number of days from planting the seeds to first pod harvest.

6. Total number of harvest. These were the number of harvesting done during the entire cropping season.

B. Yield

1. Percentage pod setting. This was computed by dividing the number of flowers produce per plant over the number of pods produce per plant.

2. Average number of seeds per pod. This was computed by dividing the number of seeds produced per plant over the number of pods per plant.

3. Average weight of pods produced per plant (g). This was computed by dividing the total weight of pods produced by sample plants over the number f sample plants.

4. Average yield per plant (g). This was computed by dividing the total yield of sample plants over the number samples.

5. Total yield per plot (kg). This was the total weight of seeds harvested per experimental plot.

6. Computed yield per hectare. This was the total yield of experimental plot during the entire cropping in each variety (20 m^2)(500).

C. Seed Quality

1. Weight of 1000 seeds (g). These were taken by weighing 1000 seeds from each variety.

2. Average seed diameter (cm). These were measured using the verner caliper.

3. Germination test. These were conducted one month from seed storage using petri dish and the ragdoll method. The seed tested were first air dried leaving at least 10% moisture content.

D. Varietal Characterization

1. The leaf shape, color and other characteristics were recorded.

2. The color of the flower and pod color at first harvest is also recorded.

3. The seed characteristics were also recorded.

E. Incidence of Insect Pest and Diseases

1. Insect pest that infest the plant during the cropping season were noted and identified during the vegetative and reproductive stages of the plant growth.

2. The plant diseases observed during the cropping season were recorded including the causal organism and the degree of infestation.

Degree of Infestation	Description
1	slight
2	moderate
3	severe

F. Meteorological Data

1. Temperature (^{o}C). This was recorded daily in the morning and evening time during the whole cropping.

G. Documentations

This was taken by photographs/pictures taken by a camera.

Figure 1. Planting chickpea at Bobok-Bisal, Bokod

Figure 2. Growth response of kabuli type chickpea in Bobok-Bisal

Figure 3. Flowering stage of chickpea

Figure 4. Overview of the experiment and the researcher

Figure 5. Disease caused by wet root rot

Figure 6. Harvesting time

Figure 7. Pod characteristics of harvested chickpea

Figure 8. Seed characteristics of harvested chickpea

Figure 9. Heliocoverpa larvae feeding on chickpea pod

Figure 10. Dry root rot of chickpea

Figure 11. Black root rot

Figure 12. Wet root rot

RESULTS AND DISCUSSION

Percentage Field Emergence

The percentage emergence of the different varieties of chickpea is presented in Table 1. The ICCV 93952 had significantly attain the highest percentage field emergence but were comparable with ICCV 93954, ICCV 94954, ICCV 2 and ICCV 95332. The kabuli type variety ICCV 95334 had significantly attain the lowest percent of field emergence.

This result may imply that this kind of crop could be grown at Bobok-Bisal, Bokod, Benguet condition.

Table 1. Percentage field emergence (%)

VARIETY	MEAN (%)
Desi Type	
ICCV 93952	95.00a
ICCV 93954	89.25a
ICCV 94954	88.00a
Kabuli Type	
ICCV 2	88.50a
ICCV 95332	76.50a
ICCV 95334	69.25b

Means with a common letter are not significantly different at 5% by DMRT

Days from Planting to Flowering

Days from planting to flowering was significantly affected by the different varieties used. Kabuli type chickpea as shown in table 2 significantly flowered earlier than desi type varieties. Apparently, the ICCV2 were the earliest to produce flower while ICCV 93952, a desi type variety were the latest.

Environmental factors like temperature certainly contributed to the duration of flowering in chickpea. As stated by Summerfield and Roberst (1988), flowering time of chickpea is variable depending on the effect of the season, sowing date, latitude and altitude. Roberts et al (1985) and Ellis et al (1994) also said that, time to flowering was a function of temperature and photoperiod.

Table 2. Days from planting to flowering

VARIETY	MEAN
Desi Type	
ICCV 93952	60.425a
ICCV 93954	54.625b
ICCV 94954	56.038b
Kabuli Type	
ICCV 2	42.488d
ICCV 95332	46.650c
ICCV 95334	48.238c

Means with a common letter are not significantly different at 5% by DMRT

Average Height at Flowering

Highly significant differences were observed among the six varieties of chickpea in relation to height at flowering as shown in Table 3. Kabuli type ICCV 95334, were significantly the tallest among the rest of the varieties cultivated which was followed by ICCV 95332. The rest of the desi type varieties including the ICCV2 were significantly comparable in terms of height at flowering.

The observed differences in height at flowering maybe an expression of the genetic make up of the chickpea introduced and could be an influenced of the temperature under Bobok-Bisal, Bokod, Benguet condition. Moreover, Poniedzialek et. al., (2005) said that, maximum plant height could be attributed combining the following inputs; choice of variety, wide spacing of 50 to 100cm and med to high plant populations; that is 20 plants per square meter and early planting.

Table 3. Average height at flowering (cm)

VARIETY	MEAN (cm)
Desi Type	
ICCV 93952	30.462c
ICCV 93954	29.845c
ICCV 94954	30.933c
Kabuli Type	
ICCV 2	30.475c
ICCV 95332	32.747b
ICCV 95334	38.495a

Means with a common letter are not significantly different at 5% by DMRT

Average Number of Lateral Branches of Flowering

The number of lateral branches at flowering as presented in Table 4 showed no significant differences among the different chickpea varieties evaluated. However, numerically, ICCV 95334 remarkably produced higher number of lateral branches per plant while the ICCV 93954 and ICCV 95332 had the least number of lateral branches produced.

Each plant produces three lateral branches, however, a maximum of five branches was observed during the conduct of the study.

Table 4. Average number of lateral branches at flowering

VARIETY	MEAN
Desi Type	
ICCV 93952	3.512a
ICCV 93954	3.475a
ICCV 94954	3.550a
Kabuli Type	
ICCV 2	3.550a
ICCV 95332	3.475a
ICCV 95334	3.788a

Means with a common letter are not significantly different at 5% by DMRT

Days from Planting to First Harvest

Table 5 shows the number of days from planting to first harvest of the cultivar evaluated. Statistical analysis showed highly significant differences among each other. Kabuli type ICCV 2 were the earliest to first pod harvest followed by ICCV 95332 and ICCV 95334. On the other hand, desi type varieties were the latest to attain first pod harvest.

As compared to days from planting to flowering, generally, the earlier the variety produces a flower, the earlier it produces pod thus, the earlier to be harvested, however the longer duration to flowering, the longer period to first pod harvest.

It is apparent in the result that, the cultivars varied maturity periods which maybe influenced by temperature and other environmental factors.

Table 5. Days from planting to first harvest

VARIETY	MEAN
Desi Type	
ICCV 93952	113.00a
ICCV 93954	108.75b
ICCV 94954	110.00b
Kabuli Type	
ICCV 2	98.00e
ICCV 95332	103.25d
ICCV 95334	106.75c

Means with a common letter are not significantly different at 5% by DMRT

Total Number of Harvest

Number of harvesting done during the cropping season is shown in Table 6. There were no significant differences among the varieties grown. Mean ranges from 3.75 to 4.00.

The harvesting of chickpea varies on its maturity, only physiologically matured pods are harvested while immature pods or the green colored pods are left in the field until for a such time that it reaches its physiological mature stage ready for the next harvesting.

Table 6. Total number of harvest

VARIETY	MEAN
Desi Type	
ICCV 93952	3.75a
ICCV 93954	4.00a
ICCV 94954	4.00a
Kabuli Type	
ICCV 2	4.00a
ICCV 95332	3.75a
ICCV 95334	3.75a

Means with a common letter are not significantly different at 5% by DMRT

Percentage Pod Setting

A variation in mean value of pod setting was observed as affected by different varieties of chickpea planted. Highest percentage pod setting was recorded from desi type varieties particularly ICCV 94954 which is not significant to ICCV 93952 and 93954 but highly significant to the kabuli type varieties. Whereas, ICCV 95334 attain the lowest percentage pod setting among the six chickpea varieties evaluated.

Table 7. Percentage pod setting (%)

VARIETY	MEAN (%)
Desi Type	
ICCV 93952	69.692ab
ICCV 93954	77.705ab
ICCV 94954	79.752a
Kabuli Type	
ICCV 2	67.870bc
ICCV 95332	66.962bc
ICCV 95334	57.580c

Means with a common letter are not significantly different at 5% by DMRT

Average Number of Seeds per Pod

Statistical analysis showed significant differences in the number of seeds produced per pod among each variety. Desi type ICCV 93954 produced the greater number of seeds per pod which significantly outnumbered the ICCV 2 and ICCV 95334, however, it is significantly comparable to ICCV 93952.

This coincides with the study of Gan et al (2003) that less number of seeds per pod was noted on kabuli type plants primarily due to higher percentage of pods that failed to fill (17-23%). Whereas, the greater number of seeds per pod was also observed in desi type chickpeas due to larger proportion (6-14%) of pods containing two seeds per pod, regardless of plant density.

Table 8. Average number of seeds per pod

VARIETY	MEAN
Desi Type	
ICCV 93952	1.328ab
ICCV 93954	1.392a
ICCV 94954	1.112bc
Kabuli Type	
ICCV 2	1.103c
ICCV 95332	1.135bc
ICCV 95334	1.090c

Means with a common letter are not significantly different at 5% by DMRT

Moreover, he also added that to increase number of seeds per unit area is to increased plant population density, whereas to increase seed per pod of kabuli is by promoting pods to fill and reducing percentage pod infertility.

Although, as it was observed in the study, a single number of seed is mostly produced per pod.

Average Weight of Pod Produced per Plant

As presented in Table 9, statistical analysis showed that the weight of pod produced per plant from the different varieties did not differ significantly. However, kabuli type ICCV 95332 acquire the highest weight of pods produced per plant.

Table 9. Weight of pod produced per plant (g)

VARIETY	MEAN (g)
Desi Type	
ICCV 93952	25.252a
ICCV 93954	29.025a
ICCV 94954	30.138a
Kabuli Type	
ICCV 2	27.063a
ICCV 95332	31.988a
ICCV 95334	31.237a

Means with a common letter are not significantly different at 5% by DMRT

Average Yield per Plant

On the yield per plant, significant differences was observed. ICCV 94954, ICCV 95332 had the highest yield per plant which is not significant to ICCV 93954, however, significant to the three remaining varieties planted.

Table 10. Average yield per plant (g)

VARIETY	MEAN (g)
Desi Type	
ICCV 93952	21.162b
ICCV 93954	25.650a
ICCV 94954	26.712a
Kabuli Type	
ICCV 2	21.725b
ICCV 95332	26.712a
ICCV 95334	22.075b

Means with a common letter are not significantly different at 5% by DMRT

Total Yield per Plot

Table 11 shows the total yield response of the desi and kabuli type chickpea planted at Bobok-Bisal, Bokod, Benguet. The kabuli type ICCV 95332 significantly produced the highest seed yield per plant among the other varieties evaluated. This variety also out yielded the ICCV 94954; which was observed to have a highest percentage pod setting, due to later harvesting making it possible to be attacked by

insects and rodents as it remained in the field. The lowest seed yield per plant on the other hand was recorded from ICCV 95334 due to an increasing number of dying plants at early stage and in pod filling stage. Diseases as observed were caused by the dry root rot and wet root rot.

Moreover, lower yield of ICCV 95334 was achieved due to lower percentage of field emergence at this particular location.

Table 11. Total yield per plot (kg)

VARIETY	MEAN (kg)
Desi Type	
ICCV 93952	2.444b
ICCV 93954	2.502b
ICCV 94954	2.735b
Kabuli Type	
ICCV 2	2.387b
ICCV 95332	3.427a
ICCV 95334	2.287b

Means with a common letter are not significantly different at 5% by DMRT

Computed Yield per Hectare

The result of yield per plot is consistent to computed yield per hectare, it follows the same trend where kabuli type ICCV 95332 attain the highest yield which significantly out yielded the ICCV 95334. As discussed earlier, result is due to the higher infestation

rate of diseases to this particular variety. Poor germination of this variety in this certain location also contributes to lower yield.

However, infestation of such diseases mentioned earlier including the pod borer and rat infestation were observed in each varieties of chickpea evaluated under Bobok-Bisal, Bokod, Benguet.

Table 12. Computed yield per hectare (kg/ha)

VARIETY	MEAN (kg/ha)
Desi Type	
ICCV 93952	1221.875b
ICCV 93954	1251.250b
ICCV 94954	1367.500b
Kabuli Type	
ICCV 2	1193.750b
ICCV 95332	1713.750a
ICCV 95334	1143.750b

Means with a common letter are not significantly different at 5% by DMRT

Weight of 1,000 Seeds

Table 13 shows the weight of 1,000 seeds per variety of chickpea was affected by the differences in the seed size. Statistical analysis showed that weight of seeds in each variety differed significantly. Large seeded kabuli type ICCV 95334 have the greatest seed weight which significantly outweighs the other entries, which then followed by

medium sized seeds ICCV 95332. On the other hand, small sized seeds ICCV2 and desi type varieties attain the lesser seed weight, where ICCV 93952 and ICCV 93954 had the meanest seeds weight.

Thus, the result indicates that seed weight depends on the seed size. The bigger the seed, the heavier the weight and the smaller it is, the lightest weight.

Moreover, Muehlbauer and Singh (1987), Poniedzialek et. al., 1996 said that in Poland, minimum kabuli type seed weight (1000) is about 495 g especially to the large seeded kabuli chickpea, whereas desi type, a small seeded has a minimum weight of 245 g per 1000 seeds, cited by Poniedzialek, 2005.

Table 13. Weight of 1,000 seeds (g)

VARIETY	MEAN (g)
Desi Type	
ICCV 93952	248.00d
ICCV 93954	249.00d
ICCV 94954	283.50c
Kabuli Type	
ICCV 2	288.25c
ICCV 95332	393.00b
ICCV 95334	547.50a

Means with a common letter are not significantly different at 5% by DMRT

Average Seed Diameter

The seed diameter of the chickpea varieties as presented in Table 14 showed highly significant differences among each other. The widest seed diameter was measured from kabuli type ICCV 95334 which significantly produced wider seeds compared to the remaining varieties. Statistical analysis also indicated that ICCV 2 is not significant to ICCV 94954 but significantly different to ICCV 93954 and ICCV 93952.

Table 14. Average seed diameter (cm)

VARIETY	MEAN (cm)
Desi Type	
ICCV 93952	0.675e
ICCV 93954	0.695d
ICCV 94954	0.710cd
Kabuli Type	
ICCV 2	0.718c
ICCV 95332	0.835b
ICCV 95334	0.920a

Means with a common letter are not significantly different at 5% by DMRT

Germination Test

Ragdoll method and Petri dish method. Germination test applying rag doll method as shown in Table 15 shows highly significant variations comparing them from each other. It is obvious that ICCV 93952 had its greatest germination percentage having the highest mean of 91.75% which is significantly similar to ICCV 93954 and ICCV 2. This is then followed by ICCV 94954 and ICCV 95332, while the large sized seed ICCV 95334 attain the lowest germination percentage among all varieties.

Using petri dish as a germination medium for chickpea on the other hand likewise shows highly significant differences from each other. ICCV 93952 still attained the highest germination percentage which significantly outnumbered the ICCV 95334 having the least germination percentage.

Comparing the two media for germinating seeds, it is apparent that ragdoll method performs better having the greater germination percentage while in petri dish, least germination percentage of seeds was noted.

The result was maybe due to rate of evaporation. Faster rate of evaporation was observed in petri dish since the container is open, the water easily evaporates making the seeds dry resulting to slower germination. While in ragdoll, rate of evaporation is low. Ragdoll method of germination meanwhile is wrapping and rolling the seeds in moist paper towel. Both germination test was stored for several days and was watered/irrigated everyday providing moisture sufficient for germination. Seedling are then counted as they germinate and removed, giving the percentage of actual germination.

Table 15. Germination test

VARIETY	MEAN	
	Ragdoll Method	Petri dish Method
Desi Type		
ICCV 93952	91.75a	67.50a
ICCV 93954	82.50ab	57.25b
ICCV 94954	72.00bc	50.00bc
Kabuli Type		
ICCV 2	83.25ab	54.50bc
ICCV 95332	69.25c	46.00c
ICCV 95334	44.50d	26.00d

Means with a common letter are not significantly different at 5% by DMRT

Varietal Characteristics

The chickpea varieties were classified/characterized based on leaf, flower and seed physical appearance.

Leaf characteristics. The leaf shape of chickpea varieties is presented in Table 16a. Desi type varieties observed to have characteristically small rounded seeds while Kabuli type are oblong shaped. In terms of leaf color, green leaves were observed in desi while Kabuli is from light (ICCV 2, ICCV 95334) to dark green (ICCV 95332).

Flower characteristics. The flower color of desi type were purple/violet while kabuli type are white colored (Table 16b). As to pod color at harvest, the six varieties were all in yellow color.

Table 16a. Leaf characteristics

VARIETY	LEAF SHAPE	LEAF COLOR
Desi Type		
ICCV 93952	small rounded	green
ICCV 93954	small rounded	green
ICCV 94954	small rounded	green
Kabuli Type		
ICCV 2	oblong	light green
ICCV 95332	oblong	dark green
ICCV 95334	oblong	light green

Table 16b. Flower and pod color

VARIETY	FLOWER COLOR	POD COLOR
Desi Type		
ICCV 93952	purple/violet	yellow
ICCV 93954	purple/violet	yellow
ICCV 94954	purple/violet	yellow
Kabuli Type		
ICCV 2	white	yellow
ICCV 95332	white	yellow
ICCV 95334	white	yellow

Seed characteristics. The seed color, shape and size of the different chickpea varieties apparently differ from each other (Table 16c). Physically, Desi type were in dark brown color, angular shape, and are in small sizes. Kabuli type on the other hand, are white-colored, owl's head shape and in small to large sizes of seeds.

Diseases and Insect Pest

Incidence of diseases and insect pest. The identified diseases attacking the root and stem were dry root rot, black root rot and wet root rot, while viral disease observed was chickpea stunt.

As to insect and pests pod borer and rodents were observed eating the crop particularly the pods.

Table 16c. Seed color, shape and size

VARIETY	SEED COLOR	SEED SHAPE	SEED SIZE
Desi Type			
ICCV 93952	dark brown	angular	small
ICCV 93954	dark brown	angular	small
ICCV 94954	dark brown	angular	small
Kabuli Type			
ICCV 2	white/cream	owl's head	small
ICCV 95332	white/cream	owl's head	medium
ICCV 95334	white/cream	owl's head	large

Table 17a. Diseases of the chickpea varieties grown in Bobok-Bisal, Bokod, Benguet

DISEASE/COMMON NAME	CAUSAL ORGANISM	DEGREE OF INFESTATION	VARIETY ATTACKED
A. Root and Stem Rot			
Black root rot		Slight	Desi and Kabuli Type
Dry root rot	*Rhizoctonia bataticola*	Slight	Desi Type: ICCV 93952, 93954, 94959
Wet root rot	*Rhizoctonia solani*	Slight	Kabuli Type: ICCV 95332 and 95334
B. Viral disease			
Chickpea stunt	Bean (pea) leafroll virus	Slight	Desi Type varieties

Table 17b. Insect and pests of the chickpea varieties grown in Bobok-Bisal, Bokod, Benguet

COMMON NAME	CAUSAL ORGANISM	DEGREE OF INFESTATION	VARIETIES ATTACKED
1. Pod borer	*Helicoverpa armigera*	Moderate	Kabuli and Desi Type
2. Rodents	*Mus booduga*	Severe	Kabuli and Desi Type

Meteorological Data

Figure 13 shows the temperature during the conduct of the study under Bobok-Bisal, Bokod, Benguet condition. The temperature ranges from 15 to 23°C during the months of December 2007 to March 2008.

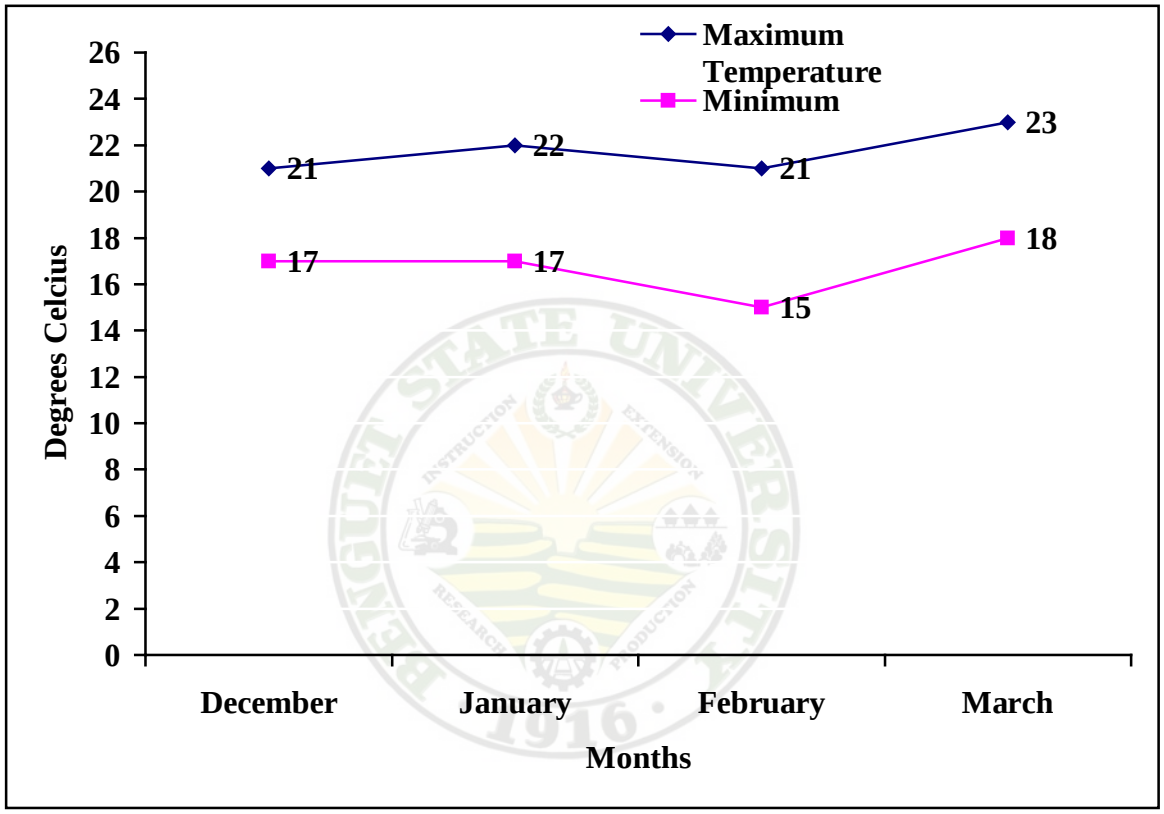

Figure 13. Temperature during the conduct of the study

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

Based on the preceding results, growth response of the chickpea kabuli type and desi type chickpea under Bobok-Bisal, Bokod, Benguet condition differs significantly. The desi type varieties particularly ICCV 93952 obtain the highest percentage field emergence of 95% while kabuli type ICCV 95334 had the lowest field emergence of 69.25%.

In terms of duration to flowering, kabuli types flowered earlier than desi types. The ICCV 2 was the earliest to produce flower, same is through with duration to first pod harvest. As to number of harvesting, this is dependent to pod maturity. Harvesting was done three to four times.

Percentage pod setting on the other hand differ significantly among each variety. Desi type, ICCV 94954 had higher percentage pod setting while kabuli type ICCV 95334 had the least pod setting.

In relation to yield, the different chickpea varieties grown differ significantly. In the total yield per plot and in computed yield per hectare, kabuli type ICCV 95332 out yielded the other varieties planted.

Variation in seed size exists among the varieties used. ICCV 95332, produce bigger seeds (0.835 cm seed diameter) than ICCV 94954 (0.710 cm seed diameter).

Weight of 1000-seeds per variety was affected by the differences in seed size. Seed size was determined based on its seed width/diameter. Kabuli type ICCV 95334 having the greater seed width, meaning the longer its size attain the heaviest weight of

1000 seeds. Likewise, the narrow the seed, the smaller its size, thus least weight of 1000 seeds which were noted from desi type varieties.

Conclusion

As a conclusion, based on the results discussed, chickpea could thrive in this particular location having atleast more than 50% field emergence.

However, yield and quality should be considered. Among the six varieties of chickpea planted, kabuli type ICCV 95332 performed well in this location.

Recommendation

It is therefore recommended that use of this variety, ICCV 95332 is best suited under Bobok-Bisal, Bokod, Benguet condition.

LITERATURE CITED

ANONYMOUS. 1997. Chickpea (Garbanzo Bean). http://hort.podue.edu/newcrop/afcm/chickpea.html

BERRADA, A., M. STACK, B., RIDDELL, M. A. BRICK, and D. L. JOHNSON. 1999. Chickpea: A Potential crop for Southwestern Colorado. Pp. 206 to 213.

ELLIS, R. H., LAWN, RJ., SUMMERFIELD RJ. Q., A. ROBERTS EH, CHAYS PM, BROWER JB. ROSE JL, YEATES, SJ. and SANDOVER S. 1994. Towards the reliable prediction of time to flowering in six annual crops: V. chickpea (*Cicer arietinum*) Exp Agric 30: 721-282.

LIU, Pu-Hai, GAN, Y., WARKENTIN, T. and McDONALD, C. 2003. Morphological Plasticity of Chickpea in Semi arid environment. Crop Science society of America. Pp. 426.

IBPGR, ICRISAT and ICARDA. 1993. Descriptions for chickpea (*Cicer arietinum* L.). International Board for plant Genetics Resources, Rome, Italy; International Crops Research Institute for Semi-Arid Tropics, Pantacheru, India and International Center for Agricultural Research in the Dry Areas, Aleppo, Syria.

LOCKHARD, J. A. and WISEMAN, A. J. 1978. Introduction to crop Husbandry. Fourth edition. Pergaman Press. Pp. 118.

MARTIN, J., LEONARD, W. and STAMP, D. L. 1976. Principles of Field Crop Production. 3rd Edition. McMillan Publishing Co. Inc. New York. Pp. 730-731.

MUEHLBAUER, FJ. and TULLU, A. 1997. *Cicer arietinum* L. New Crop Fact sheet. Center for new crops and Plant Products. Purdue University, West Lafayette.

NENE, Y. L., REDDY, M. V., HAWANE, M. P., GANEKAR, A. M., and AMIN, K. S. 1991. Field diagnosis of chickpea diseases and their control. Information Bulletin no. 28. Pantacheru, Andhra Pradesh 502 324, India: International Crops Research Institute for the Semi-arid tropics.

PONIEDZIALEK, M., SKOWERA, B., and DZIAMBA, S. 2005. The effect of locality and sowing term on chosen morphological features of two chickpea (*Cicer arietum* L.) cultivars. Department of Vegetable Crops, Agricultural University in Krakow Poland. 37-46 pp.

SINGH, C. 1983. Modern Techniques of Raising Field Crop Production. Oxford and IBH Publishing Co., New Delhi. Pp. 169-183.

SUMMERFIELD, RJ. and ROBERTS, E. H. 1988. Photothermal regulation of flowering in pea, lentil, faba bean and chickpea. Dordecht, The Netherlands. Kluwer Academic Publishers. Pp. 911-922.

STALLKNECHT, G., MILLER, P., NEIL, K., BUSSAN, A. J. and RIESSELMAN, J. 1999. Growing chickpeas (Garbanzo Beans) in Montana.

APPENDICES

APPENDIX TABLE 1. Percentage field emergence (%)

VARIETY	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Desi Type						
ICCV 93952	98	100	86	96	380	95.00
ICCV 93954	99	96	68	94	357	89.25
ICCV 94954	95	85	78	94	352	88.00
Kabuli Type						
ICCV 2	97	91	74	92	354	88.50
ICCV 95332	92	83	60	71	306	76.50
ICCV 95334	87	67	51	72	277	69.25

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROBABILITY 0.05	0.01
Replication	3	2031.500	677.167			
Factor A	5	1830.333	366.067	12.48**	2.90	4.56
Error	15	440.000	29.333			
Total	23	4301.833				

** highly significant Coefficient of Variation: 6.42%

APPENDIX TABLE 2. Days from planting to flowering

VARIETY	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Desi Type						
ICCV 93952	66.4	61.5	65.65	51.15	241.70	60.425
ICCV 93954	55.9	60.45	55.5	46.65	218.50	54.625
ICCV 94954	60.4	56.25	59.7	47.8	224.15	56.038
Kabuli Type						
ICCV 2	42.15	46.05	46.05	35.7	169.95	42.488
ICCV 95332	46.5	46.95	51.65	41.5	186.60	46.650
ICCV 95334	46.15	49.65	53.05	44.1	192.95	48.238

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROBABILITY	
					0.05	0.01
Replication	3	394.681	131.560			
Factor A	5	901.414	180.283	26.19**	2.90	4.56
Error	15	103.254	6.884			
Total	23	1399.350				

** highly significant Coefficient of Variation: 5.10%

APPENDIX TABLE 3. Average height at flowering (cm)

VARIETY	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Desi Type						
ICCV 93952	30.55	30.52	31.125	29.65	121.85	30.462
ICCV 93954	29.9	29.3	29.68	30.5	119.38	29.845
ICCV 94954	31.36	29.76	31.35	31.26	123.73	30.933
Kabuli Type						
ICCV 2	30.5	29.6	31.97	29.83	121.90	30.475
ICCV 95332	32.025	32.85	31.75	34.36	130.99	32.747
ICCV 95334	39.05	40.43	37.2	37.3	153.98	38.495

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROBABILITY 0.05	PROBABILITY 0.01
Replication	3	0.075	0.025			
Factor A	5	212.256	42.451	3474**	2.90	4.56
Error	15	18.332	1.222			
Total	23	230.663				

** highly significant Coefficient of Variation: 5.10%

APPENDIX TABLE 4. Average number of lateral branches of flowering

VARIETY	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Desi Type						
ICCV 93952	3.5	3.25	3.5	3.8	14.05	3.512
ICCV 93954	3.5	3.45	3.35	3.6	13.90	3.475
ICCV 94954	3.4	3.4	3.55	3.85	14.20	3.550
Kabuli Type						
ICCV 2	3.3	3.6	3.45	3.85	14.20	3.550
ICCV 95332	3.45	3.35	3.5	3.6	13.90	3.475
ICCV 95334	3.55	3.45	4.0	4.15	15.15	3.788

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROBABILITY 0.05	PROBABILITY 0.01
Replication	3	0.566	0.189			
Factor A	5	0.275	0.055	2.77^{ns}	2.90	4.56
Error	15	0.298	0.020			
Total	23	1.138				

ns = not significant

Coefficient of Variation: 3.96%

APPENDIX TABLE 5. Days from planting to first harvest

VARIETY	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Desi Type						
ICCV 93952	115	114	115	108	452	113.00
ICCV 93954	110	111	110	104	435	108.75
ICCV 94954	113	110	112	105	440	110.00
Kabuli Type						
ICCV 2	99	100	100	93	392	98.00
ICCV 95332	104	104	106	99	413	103.25
ICCV 95334	108	108	110	101	427	106.75

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROBABILITY 0.05	PROBABILITY 0.01
Replication	3	199.792	66.597			
Factor A	5	569.375	113.875	163.33**	2.90	4.56
Error	15	10.458	0.697			
Total	23	779.625				

** = highly significant

Coefficient of Variation: 0.78%

APPENDIX TABLE 6. Total number of harvest

VARIETY	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Desi Type						
ICCV 93952	4	4	4	3	15	3.75
ICCV 93954	4	4	4	4	16	4.00
ICCV 94954	4	4	4	4	16	4.00
Kabuli Type						
ICCV 2	4	4	4	4	16	4.00
ICCV 95332	4	4	3	4	15	3.75
ICCV 95334	4	4	3	4	15	3.75

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROBABILITY 0.05	PROBABILITY 0.01
Replication	3	0.458	0.153			
Factor A	5	0.375	0.075	0.63ns	2.90	4.56
Error	15	1.792	0.119			
Total	23	2.625				

ns = not significant

Coefficient of Variation: 8.92%

APPENDIX TABLE 7. Percentage pod setting (%)

VARIETY	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Desi Type						
ICCV 93952	65.13	76.24	67.02	70.38	278.77	69.692
ICCV 93954	76.00	83.40	78.85	72.73	310.98	77.705
ICCV 94954	81.83	85.13	74.10	77.95	319.01	79.752
Kabuli Type						
ICCV 2	67.10	75.22	66.26	62.90	271.48	67.870
ICCV 95332	72.47	73.00	52.11	70.27	267.85	66.962
ICCV 95334	76.09	53.70	52.83	44.70	230.32	57.580

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROBABILITY 0.05	0.01
Replication	3	369.350	123.118			
Factor A	5	1292.137	258.547	5.62**	2.90	4.56
Error	15	689.856	45.990			
Total	23	2351.946				

** = highly significant Coefficient of Variation: 9.70%

APPENDIX TABLE 8. Average number of seeds per pod

VARIETY	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Desi Type						
ICCV 93952	1.10	1.28	1.60	1.33	5.31	1.328
ICCV 93954	1.24	1.77	1.40	1.16	5.57	1.392
ICCV 94954	1.05	1.16	1.12	1.12	4.45	1.112
Kabuli Type						
ICCV 2	1.07	1.09	1.15	1.10	4.41	1.103
ICCV 95332	1.20	1.14	1.08	1.12	4.54	1.135
ICCV 95334	1.06	1.09	1.13	1.08	4.36	1.090

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROBABILITY 0.05	PROBABILITY 0.01
Replication	3	0.083	0.028			
Factor A	5	0.346	0.069	3.64*	2.90	4.56
Error	15	0.285	0.019			
Total	23	0.714				

* = Significant

Coefficient of Variation: 11.56%

APPENDIX TABLE 9. Average weight of pods produce per plant (g)

VARIETY	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Desi Type						
ICCV 93952	22.6	27.3	32.05	19.06	101.01	25.252
ICCV 93954	24.5	31.8	29.80	30.00	116.10	29.025
ICCV 94954	30.5	34.15	26.30	29.60	120.55	30.138
Kabuli Type						
ICCV 2	21.9	36.00	22.35	28.00	108.25	27.063
ICCV 95332	29.2	24.55	28.20	46.00	127.95	31.988
ICCV 95334	30.0	24.85	23.30	46.80	124.95	31.237

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROBABILITY 0.05	PROBABILITY 0.01
Replication	3	174.325	58.108			
Factor A	5	131.766	26.353	0.54ns	2.90	4.56
Error	15	733.356	48.890			
Total	23	1039.447				

ns = not significant

Coefficient of Variation: 24.01%

APPENDIX TABLE 10. Average yield per plant (g)

VARIETY	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Desi Type						
ICCV 93952	21.05	24.70	20.35	18.55	84.65	21.162
ICCV 93954	23.00	28.05	26.05	25.50	102.60	25.650
ICCV 94954	27.90	30.05	23.00	25.90	106.85	26.712
Kabuli Type						
ICCV 2	19.80	21.15	20.80	25.15	86.90	21.725
ICCV 95332	24.80	27.05	25.60	29.40	106.85	26.712
ICCV 95334	25.40	20.60	20.90	21.40	88.30	22.075

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROBABILITY 0.05	PROBABILITY 0.01
Replication	3	19.809	6.603			
Factor A	5	137.481	27.496	4.91**	2.90	4.56
Error	15	84.081	5.605			
Total	23	241.372				

** = highly significant Coefficient of Variation: 9.86%

APPENDIX TABLE 11. Total yield per plot (kg)

VARIETY	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Desi Type						
ICCV 93952	2.090	2.605	1.820	2.260	9.775	2.444
ICCV 93954	2.607	2.938	2.095	2.370	10.010	2.502
ICCV 94954	3.165	3.157	2.290	2.328	10.940	2.735
Kabuli Type						
ICCV 2	2.340	2.320	2.340	2.550	9.550	2.387
ICCV 95332	3.062	3.131	3.841	3.676	13.710	3.427
ICCV 95334	2.036	2.129	2.156	2.829	9.150	2.287

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROBABILITY 0.05	PROBABILITY 0.01
Replication	3	0.103	0.034			
Factor A	5	3.449	0.690	4.61**	2.90	4.56
Error	15	2.245	0.150			
Total	23	5.797				

** = highly significant Coefficient of Variation: 14.71%

APPENDIX TABLE 12. Computed yield per hectare (kg/ha)

VARIETY	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Desi Type						
ICCV 93952	1045.0	1302.5	1410.0	1130.0	4887.50	1221.875
ICCV 93954	1303.50	1469.0	1047.5	1185.0	5005.00	1251.250
ICCV 94954	1582.50	1578.5	1145.0	1164.0	5470.00	1367.500
Kabuli Type						
ICCV 2	1170.0	1160.0	1170.0	1275.0	4775.00	1193.750
ICCV 95332	1531.0	1565.5	1920.5	1838.0	6855.00	1713.750
ICCV 95334	1018.0	1064.5	1078.0	1414.5	4575.00	1143.750

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROBABILITY 0.05	PROBABILITY 0.01
Replication	3	24636.531	8212.111			
Factor A	5	874086.719	174817.340	4.71**	2.90	4.56
Error	15	556843.656	37122.910			
Total	23	1455566.906				

** = highly significant

Coefficient of Variation: 14.65%

APPENDIX TABLE 13. Weight of 1000 seeds (g)

VARIETY	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Desi Type						
ICCV 93952	244	248	252	248	992	248.00
ICCV 93954	249	251	247	249	996	249.00
ICCV 94954	285	280	286	283	1134	283.50
Kabuli Type						
ICCV 2	285	290	290	288	1153	288.25
ICCV 95332	395	396	388	393	1572	393.00
ICCV 95334	545	550	548	547	2190	547.50

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROBABILITY 0.05	PROBABILITY 0.01
Replication	3	36.125	12.042			
Factor A	5	273291.875	54658.375	4749.46**	2.90	4.56
Error	15	172.625	11.508			
Total	23	273500.625				

** = highly significant Coefficient of Variation: 1.01%

APPENDIX TABLE 14. Average seed diameter (cm)

VARIETY	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Desi Type						
ICCV 93952	0.68	0.68	0.68	0.66	2.70	0.675
ICCV 93954	0.68	0.68	0.12	0.70	2.78	0.695
ICCV 94954	0.71	0.12	0.71	0.70	2.84	0.710
Kabuli Type						
ICCV 2	0.72	0.73	0.71	0.71	2.87	0.718
ICCV 95332	0.84	0.84	0.82	0.84	3.34	0.835
ICCV 95334	0.92	0.90	0.94	0.92	3.68	0.920

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROBABILITY	
					0.05	0.01
Replication	3	0.000	0.000			
Factor A	5	0.188	0.038	204.04**	2.90	4.56
Error	15	0.003	0.000			
Total	23	0.191				

** = highly significant

Coefficient of Variation: 1.79%

APPENDIX TABLE 15. Germination test (ragdoll method)

VARIETY	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Desi Type						
ICCV 93952	90	94	91	92	367	91.75
ICCV 93954	80	84	86	80	330	82.50
ICCV 94954	68	82	66	72	288	72.00
Kabuli Type						
ICCV 2	90	90	70	83	333	83.25
ICCV 95332	76	70	62	69	277	69.25
ICCV 95334	56	40	38	44	178	44.50

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROBABILITY 0.05	PROBABILITY 0.01
Replication	3	124.458	41.486			
Factor A	5	5478.375	1095.675	19.03**	2.90	4.56
Error	15	863.792	57.586			
Total	23	6466.625				

** = highly significant Coefficient of Variation: 10.27%

APPENDIX TABLE 16. Germination test (petri dish method)

VARIETY	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
Desi Type						
ICCV 93952	70	66	70	64	270	67.50
ICCV 93954	85	50	64	57	229	57.25
ICCV 94954	42	60	48	50	200	50.00
Kabuli Type						
ICCV 2	60	58	46	54	218	54.50
ICCV 95332	50	40	48	46	184	46.00
ICCV 95334	20	30	28	26	104	26.00

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROBABILITY 0.05	PROBABILITY 0.01
Replication	3	5.792	1.931			
Factor A	5	3883.208	776.642	22.62**	2.90	4.56
Error	15	514.958	34.331			
Total	23	4403.958				

** = highly significant Coefficient of Variation: 11.67%

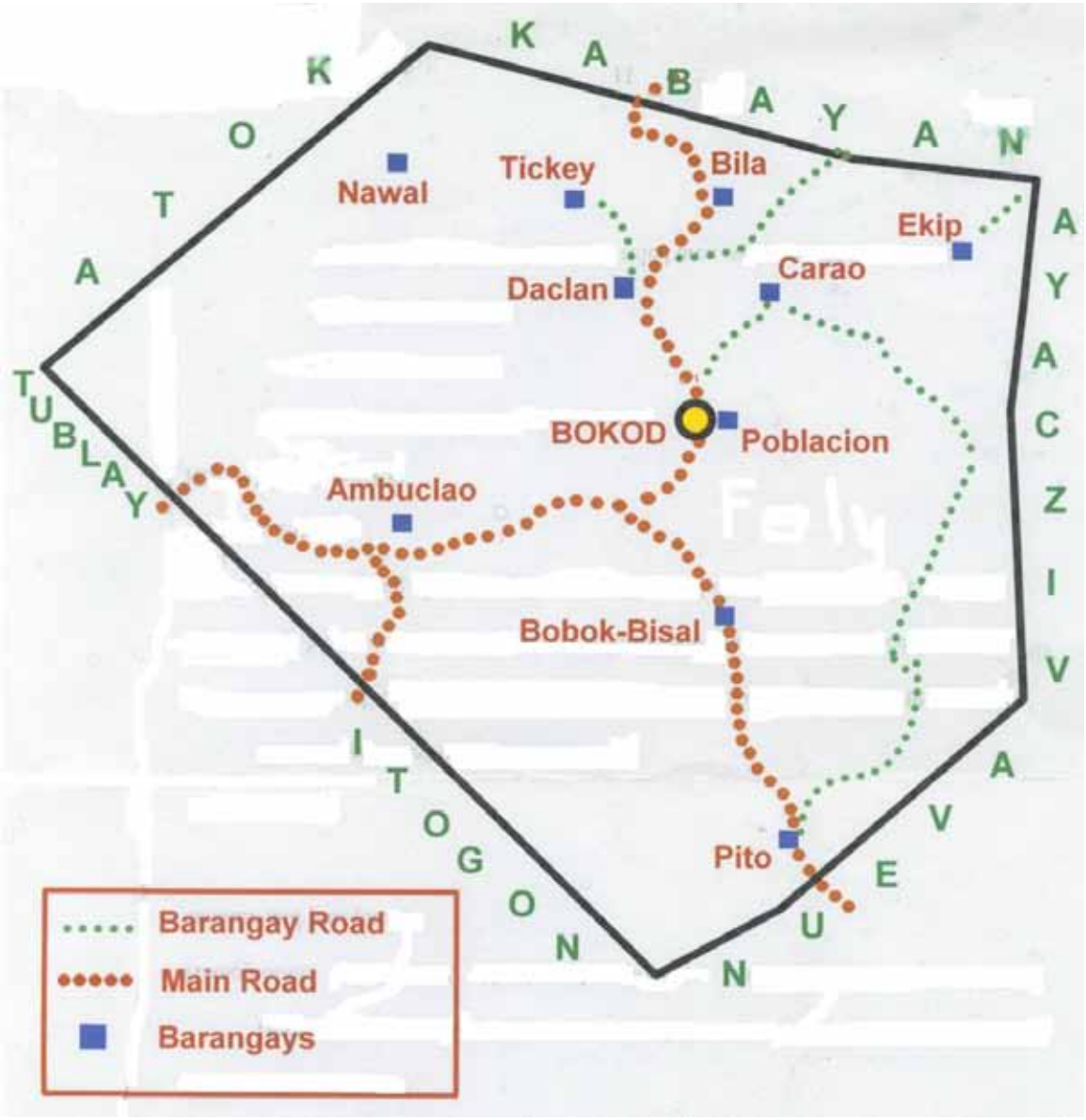

Figure 14. Location of the study