

## **BIBLIOGRAPHY**

LUMICQUIO MYLA R. OCTOBER 2010. Growth and Yield of Chickpea (*Cicer arietinum L.*) as Affected by Duration of Weed Control Under La Trinidad, Benguet Condition.  
Benguet State University, La Trinidad Benguet.

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## **ABSTRACT**

The study was conducted to determine the growth and yield of chickpea as affected by duration of weed control under La Trinidad Benguet Condition, and to determine the stage where yield will not be affected with the presence of weeds; and to determine the effect of weeds on the stages of chickpea.

Findings showed significant differences between the variety and duration of weed control with regards to the number of days from planting to 50% flowering, average total number of pods per plant, average number of filled pods and unfilled pods, average seed yield per plant, total yield per plot, computed yield per hectare and weight of 100 seeds. The average number of primary stems at flowering and number of days from planting to harvesting was not significantly affected by the treatments.

Kabuli type ICCV 953343 plants that were weed free from sowing to harvesting were significantly the earliest to attain flowering stage after 55.75 days and were the tallest plants. ICCV 92311 a Kabuli type cultivar that were weed free from sowing to harvesting had significantly produced the highest number of pods and filled pods per plant. Desi type ICCV 94954 that were weed free from sowing to seedling stage had significantly the lowest number of unfilled pods per plant. ICCV 92311 that were weed free from sowing to harvesting had

significantly the highest yield per plant, yield per plot and yield per hectare. Kabuli type ICCV 07307 a big seeded cultivar had significantly the heaviest weight of 100 seeds.

Based on the findings, it is therefore recommended that weeding or removal of weeds in chickpea from sowing to harvesting should be done for higher yield per plant and per plot. Likewise, growing Desi type variety ICCV 93952 and Kabuli type 92311 is recommended for La Trinidad, Benguet condition.



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## INTRODUCTION

Chickpea (*Cicer arietinum L.*) also known as garbanzos bean, Indian pea, ceci bean, bengal gram, Kabuli chana, kadali kaalu, sanaga pappu, shimbra kadala) is an edible legume of the family Fabacea, subfamily Fabiodeacea. Chickpeas are high in protein and one of the earliest cultivated vegetables as shown by the 7500 year old remains that have been found in Middle East. Chickpea seeds germinate at an optimum temperature of 28-33<sup>0</sup>C in about 5-6

It has a strong taproot system with 3 or 4 of lateral roots. The roots grow 1.5-2.0 deep. Stem is erect, branched, viscous, hairy, terete, herbaceous, green, and solid. The branches are usually quadrangular, ribbed and green. There are primary, secondary and tertiary branches (Cubero, 1987). Chickpea is herbaceous annual plant which branches from the base. It is almost a small bush with diffused spreading branches. The plant is mostly covered with glandular and non glandular hairs but some genotypes do not possess hair. The stipules are ovate to triangular in shade and serrated. They are 3-5mm long 2-4mm wide. The longest margin is toothed and the smaller one is entire. The external surface of the chickpea plant, except the corolla, is densely covered with glandular hairs. Solitary flowers are borne in an axillary raceme. Sometimes there are two to three flowers on the same node. Such flowers possess both a peduncle and a pedicel. The raceme peduncle is 6-30mm in length. At flowering, the floral and racemal portions of the peduncle form a straight line, giving the appearance that the flowers are placed on the leafy axil by a single peduncle. Chickpea leaves are petiolate, compound and unimparipinnate. Some lines having simple leaves. The rachis is 3-7cm long with grooves on its upper surface. The leaflets are 8-17mm long 5-14cm long with wide, opposite or alternate with a terminal leaflet. The leaves are usually serrated. The shape of the leaflets is ovate, leaves are pubescent.

Chickpea flowers are complete and bisexual and have papilionaceous corolla which are white, pink, purple or blue in color. Chickpeas mature in 3-7 months and the leaves turn brown

or yellow during maturity for dry seeds, the plants are harvested at maturity by cutting them close to the ground or uprooting. Chickpeas are usually stored in bags, but are more subject to insect damage than when stored in bulk.

Chickpea (*Cicer arietinum L.*) has one of the highest nutritional compositions of any dry edible legume. According to the ICRISAT, chickpea seeds contain an average; 23% protein, 64% total carbohydrates (47% starch, 6% soluble sugar), 5% fat 6% crude fiber and 3% ash. There has a high mineral content; 340mg/100g Iron and 3mg/100g of Zinc. Recent studies by government agencies have also shown that Chickpeas can assist in lowering of cholesterol in the bloodstream. Because it is grown for its nutritious edible seeds, the whole seed are used in flour for preparing variety of snack, raw roasted fresh green chickpeas and straw as a livestock feed. Chickpeas are good sources of zinc, foliate and protein. They are also very high in dietary fiber and hence, a healthy source of carbohydrates for persons with insulin sensitivity or diabetes. Chickpea are rich in mineral and vitamins.

Chickpea is mainly used for human consumption and only a small proportion is used as feed. The Kabuli type (white cream coat) is used as a whole seeds, chickpea is also known for its use in herbal medicine and cosmetics.

The study was conducted to:

1. determine the growth and yield of chickpea as affected by duration of weed control under La Trinidad Benguet condition.
2. determine the growth stage where yield will not be affected with the presence of weeds
3. determine the effect of weeds on the different growth stages of chickpea.



The study was conducted at Benguet State University La Trinidad from November 2009 to May 2010.



## REVIEW OF LITERATURE

### Botany of Chickpea

Taxonomy, morphology and floral biology. Cicer which was classified under vivacea alef, was later reported to belong to the monogenetic tribe, cicereae. The genus include 9 annuals and 34 perennial herbs. Cross ability and fertility of hybrids in interspecific crosses have been used as basis to classify the annuals into four cross ability crops. The first group includes the cultivated chickpea (*Cicer arietum L.*) and *C. reticulum*. Chickpea plants can be described as plants in which stems are branched, erect, or spreading, sometimes shrubby much branched, 0.2-1m tall, glandular pubescent, olive, dark green or bluish green in color. Root system is robust, up to 2m deep, but major portion up to 60cm. Leaves imparipinnate, glandular pubescent with 3-8 pairs of leaflets and atop of leaflet (racius ending in a leaflet); leaflets ovate to elliptic, 0.6-2.0cm long, 0.3-1.4cm wide; margin serrate, apex acuminate to aristate, base cuneate, stipules 2-5 toothed, stipules absent. Flowers solitary, sometimes 2 per inflorescence, axillary; peduncles 0-6cm long, pedicels 0.5-1.3cm long, bracts triangular or tiparite, calyx 7-10mm long; corolla white pink, purplish. The stamina column is diadelphous and the ovary is sessile, inflated pubescent (Duke 1982). Pod rhomboid ellipsoid, 1-2 with three seeds as a maximum and inflated, glandular pubescent. Seed color cream, yellow, brown, black, or green, rounded, seed coat smooth, laterally compressed with a median groove around two thirds of the seed; germination cryptocotylar (Vander Maesan and Somaatmadja, 1987).

### Ecology of Chickpea

Chickpea is a self pollinated crop. Cross pollination is rare; only 0-1% is reported (Singh, 1987; Smithson., 1985). Grown usually as a rain fed cool weather crop or as a dry climate in semi-arid region. Optimum conditions include 18-26<sup>0</sup>C day and 21-29<sup>0</sup>C night temperatures and





annual rainfall of 600-1000mm (Duke, 1981; Muehler, 1982). The Palouse region of the States Washington and Idaho appears to be well suited for chickpea crop and it has thrived in the coastal areas and in the central valley. Chickpea also thrives on sunny sites in a cool, dry climate on well drained soils and grows on residual moisture in the post rainy season of sub tropical winter or spring of the northern hemisphere. They are generally grown on heavy black or red soil pH 5.8-8.6. Frost, hailstones, and excessive rains damage the crop. Though sensitive to cold, some cultivars can tolerate as low as  $9-5^{\circ}\text{C}$  in early stages or under snow cover. Daily temperature fluctuations are desired with cold nights with dewfall. Relative humidity of 21-41% is optimum from seed setting. In virgin sandy soils or for the first planting in heavier soils, inoculation is said to increase yield by 10-67%” (Duke, 1981). Although spoken of “day neutral,” chickpea is a quantitative long day plant but flowers in every photoperiod.

### Growth Habits

Chickpea is an herbaceous annual plant which branches from the base. It is almost a small bush with diffused, spreading branches. The plant is mostly covered with glandular or non glandular hairs but some genotypes do not possess hair. Based on seed and color, cultivated chickpeas are of two types Kabuli, which has lighter colored, larger seeds and a smoother coat, mainly grown in southern Europe, Northern Africa, Afghanistan and Chile also introduced during the 18<sup>th</sup> century to the Indian subcontinent. Desi type, which has small, darker seeds and rough coat, cultivated mostly in the Indian subcontinent, Ethiopia, Mexico and Iran.

Because of its deep top root system, chickpea can withstand drought conditioned by extracting water deeper in the soil profile.

Flowers are self pollinated which are borne in groups of two or three and ½ to 1 inch long in purple, white, pink or blue colors depending upon the variety. Each flower produces a short,



pubescent pod which is  $\frac{3}{4}$  inches long and which appears to be inflated. The seeds come with either rough or smooth surfaces and can be cream, yellow, brown, black or green in color. There is a definite groove visible between the cotyledon about two thirds of the way around the seed with a break like structure present.

### Environmental Condition

Climate largely determines where, when and what plants to grow. Climate includes consideration of precipitation, humidity, sky condition, temperature, wind and atmospheric pressure which in turn, is influenced by location, latitude, season, elevation, time of the day and local factors such as drainage.

Chickpea are grown in the Mediterranean, Western Asia, the Indian subcontinent and Australia. Domestically they can be sprouted with in a few days all year round. Chickpea germinate at an optimum temperature of 28-33<sup>0</sup>C and moisture level o 25% after 5-6 days of sowing the seeds.

### Soil Requirement

Legume crop can be grown in any type of soil provided water is available. They perform best in soil that is granular, fertile, well drained and relative free from nematodes and fusarium diseases. Clay loam soil is probably the best type for commercial production. They thrive in moderately acidic soil with a range of 5.0-6.0 (PCARRD, 1975).

Chickpea does best on fertile sandy loam with good internal drainage. Good drainage is necessary because even short periods of flooded or water logged fields reduce growth and increase susceptibility to root and stem rots.



### Seed Preparation and Germination

Good quality certified seeds should always be used. This should be high in germination percentage with 85% free from damage and free of weed seeds. Good quality seeds do not need to be treated with an insecticide or fungicide, but if there were past problems with Pythium or Rhizoctonia rots in the area, seed should be treating prior to planting (Anonymous, 2007).

### Crop Culture

Field cultivation. Chickpeas are propagated from seeds. Seeds are broadcasted or drilled in rows 25-60cm apart between seed at a depth 2-12cm wide with soil well pressed down. Seed is sown in spring when the ground has warmed or when the rains recede. Depending on the region, seedling rates vary from 25-40kg/ha to 80-120kg/ha, depending on the area and seed type. Chickpea may be cultivated as a crop, or mixed with barley, linseed, mustard, sorghum or wheat. Chickpea are also grown as a catch crop in sugarcane fields and often a second crop after rice. Although they are usually considered as dry land crop, they grew well on rice lands.

Chickpeas are intercultivated once about 3-4 weeks after sowing; the crop develops enough shade to smother seeds. In other areas weeding is recommended; on poor soils, manure or compost is beneficial. Seed inoculation improves yield only for crops grown for the first time after rice. Irrigation at 45 and 75 days after planting is useful. Fertilizers have often failed to increase yield substantially because of fixation of phosphorous by soils and the accumulation of nutrients in the upper layer of the soil which often dry.

Harvesting. Chickpeas mature in 3-7 months and the leaves turn brown/yellow during maturity. For dry seeds, the plants are harvested at maturity or slightly earlier by cutting them close to the ground or uprooting. The plants are stacked in the field as for a few days to dry and later the crop is threshed by trampling or beating with wooden flails. The chaff is separated from



the grain by winnowing. Tall cultivars stored in bags, but are more subject to insect damage than when stored in bulk. Proper cleaning, drying and aeration are necessary to control seed beetles. A thin coating with vegetable oil can reduce storage damage. Sometimes baskets, made from rice straw are used as storage containers.

Yield and economics. Greater and more stable yields are the major goals of breeding programs. Chickpea yields usually average 400-600kg/ha, but can surpass 2000kg/ha in irrigated crops are 20-28% higher than rain fed crops. Two types of chickpea are recognized, Desi and Kabuli.

In a 3 cultivar trial in India, dry matter yields from 9400-12000kg/ha. In India and Pakistan, chickpeas are consumed locally, and about 56% of the crops is retained by growers (Duke, 1981). In United States and Europe, chickpeas are marketed dried or canned for various vegetable mixtures. Mashed chickpea mix with oils and spices is popular *hors d'oeuvre* in the Mediterranean and the Middle East.

The major chickpea growing countries are India, Pakistan, and Turkey in Asia, Ethiopia in Africa, California and Washington States in the U.S...Chickpea production increased from 1980-1990 by about a million tons at 1.8% annually and there was 5.6% increase in yield over the decade.

### Nutritional Value

Legumes vegetables are one of the promising vegetable crop produced in the Philippines. The crop is not only important for human nutrition but also for farmers. Aside from the benefits it provides to man and animals, legumes are beneficial to the soil, for they replenish the soil nitrogen. Legumes generally help maintain and conserve soil fertility. Chickpea protein digestibility is the highest among the dry edible legumes. It is mainly used as a healthy source of



carbohydrates for persons and for human consumption. It is also known for its use in the herbal medicine and cosmetics.

Chickpeas are helpful source of zinc, foliate and protein. They are also very high in dietary fiber and hence; it is mainly used healthy source of carbohydrates for persons with insulin sensitivity or diabetes. Chickpeas are low in fat and most of these are polyunsaturated. A 100g of matured boiled chickpea seeds contain 164 calories, 2.6g of fat, and 7.6g of dietary fiber and 8.9g of protein. Chickpea also provide dietary calcium with some source citing the garbanzos calcium content as about the same as yogurt and close to milk. According to the ICRISAT chickpea seeds contain an average; 23% protein, 64% carbohydrates, 5% fat, 6% crude fiber, 3% ash, and high mineral content. Phosphorous was found to be 340mg/100g, calcium 190mg/100g, magnesium 140mg/100g, iron 7mg/100g and zinc 3mg/100g.

Unripe chickpeas are often picked out of the pod eaten raw and the leaves are eaten as green vegetables in salads. In the Philippines, garbanzo beans preserved in syrup are eaten as sweets and in desserts such as halo-halo.

### Traditional Medicines

Chickpea is the most hypocholesterimic agent among the food legumes. Germinated chickpea seeds were reported to be effective in controlling cholesterol level in fats. The glandular secretion of the leaves, stems, and pods consist of malic and oxalic acids, giving the sour taste. In India these acids are used and are harvested by spreading thin muslin cloth during the night. Medical application includes uses as aphrodisiacs for bronchitis, cataract, cutamenia, constipation, diarrhea, dyspepsia, flatulence, snake bite, sun stroke and warts. Acids are supposed to lower the blood cholesterol levels. Seeds are considered antibiotics.



## METHODOLOGY

### Materials

The materials that were used in the study were seeds of chickpea, garden tools, record book and identifying pegs.

### Methods

The study was conducted at Benguet State University, La Trinidad Benguet. The study was laid out in Randomized Complete Block Design (RCBD) in factorial arrangement with 3 replications per treatment combination in 1m x 3m plot. The seeds were planted singly at a distance of 30 cm between rows and between hills. The treatments were as follows:

#### Factor A (Duration of Weed Control)

- D<sub>1</sub> – Weed free from sowing to seedling stage
- D<sub>2</sub> – Weed free from sowing to first flowering stage
- D<sub>3</sub> – Weed free from sowing to first pod stage
- D<sub>4</sub> – Weed free from sowing to harvesting (from ICRISAT)

#### Factor B (Cultivar)

| <u>Desi Type</u>            | <u>Kabuli Type</u>          |
|-----------------------------|-----------------------------|
| V <sub>1</sub> – ICCV 93952 | V <sub>4</sub> – ICCV 92311 |
| V <sub>2</sub> – ICCV 93952 | V <sub>5</sub> – ICCV 95334 |
| V <sub>3</sub> – ICCV 06102 | V <sub>6</sub> – ICCV 07307 |

Care and maintenance. Uniform care and maintenance was done to all samples throughout the duration of the study. There were 3 samples per treatment.



Data gathered were the following:

1. Vegetative Growth

a. Days from planting to 50% flowering. This was taken when 50% of the plant population had opened flower.

b. Average plant height at flowering (cm). This was taken at flowering stage (first flower) the height of 3 sample plants were measured at flowering stage.

c. Number of primary stems at flowering. This was taken at flowering stage (first flower). This was gathered by counting the lateral branches at flowering.

This was computed as follows.

$$\text{Average No. of Lateral Branches at Flowering} = \frac{\text{No. of Lateral Branches of Sample Plants}}{\text{Sample Plants}}$$

d. Days from planting to harvesting. This was taken by counting the days from planting to harvesting.

2. Yield

a. Average number of pods per plant. Mean of 3 representative plants.

b. Average number of filled pods per plant. Total number of filled pods taken from the average of 3 sample plants per plot.

c. Average number of unfilled pods. Total number of unfilled pods taken from the average of 3 sample plants.

d. Average seed yield per plant (g). This was taken using the formula.

$$\text{Seed yield per plant} = \frac{\text{Seed yield of sample plants}}{\text{Number of sample plants}}$$

e. Total yield per plot (3m<sup>2</sup>). Total yield of experimented plot (gram)

f. Computed yield per hectare (kg/ha). This was computed using the formula.





$$\text{Yield per Hectare} = \text{Total Yield per Plot} \times 3,333.33$$

### 3. Seed Quality

a. Weight of 100 seeds (gram). This was taken by weighing 100 seeds per treatment.

5. Meteorological data. Temperature, relative humidity, and rainfall during the study were recorded.

4. Common weeds growing in the experimental area. This was taken by listing the Common weeds growing in the experimental area with their common names and scientific names.

6. Documentation of the study. This was taken through pictures.

Figure 1 shows the temperature, relative humidity and rainfall during the conduct of the study under La Trinidad, Benguet condition from November, 2009 to March, 2010. The temperature ranged from 21.05°C on the month of December to 22.95°C on the month of February. The month of November recorded a temperature of 22.2°C, the month of February with 22.6°C; and in the month of March with a temperature of 22.9°C.

The relative humidity recorded during the conduct of the study ranged from 82.75% on December to 88% on the month of January. The month of November had a relative humidity of 84%, month of February with 84.5% and month of March with a relative humidity of 86.75%.

There was no recorded rainfall during the duration of the study.

Figure 2 shows the land preparation of the experimental area. Figure 3 shows the sowing of seeds of the chickpea, kabuli and Desi type. Figure 4 shows the flowering stage of chickpea plants. Figure 5 shows the overview of the experimental area and figure 6 shows the harvesting of the plants. Figure 7-15 shows the graph or the result of the experiment. Figure 7 shows the





number of days from planting to 50% flowering. ICCV 92311 that were weed free from sowing to first pod stage were the earliest to attain 50% flowering after 57.33 days while ICCV 93952 that were weed free from sowing to seedling stage were the latest to attain 50% flowering after 72.33. Figure 8 shows the average plant height at flowering. ICCV 95334 that were weed free from sowing to first pod sage were the tallest plants at flowering with 58.83cm while ICCV 94954 that were weed free from sowing to first flowering stage had the shortest plant of 38.93 cm. Figure 9 shows the average total number of pods per plant. ICCV 92311 that were weed free from sowing to harvesting produced the highest number of pods per plant with a mean of 337.66 while ICCV 94954 that were weed free from sowing to seedling stage produced the lowest number of pods with only 58 per plant. Figure10 shows the average number of filled pods per plant. ICCV 92311 plants that were weed free from sowing to harvesting had the highest number of filled pods with a mean of 349.99 while ICCV 94954 plants that were weed free from sowing to first seedling stage had the lowest number of filled pods with a mean of only 48.77. Figure 11 shows the average number of unfilled pods per plant. ICCV 94954 weed free plants from sowing to first flowering stage had the lowest number of unfilled pods with a mean of 13.16 while ICCV 06102 those that were also weed free plants from sowing to first flowering stage had the highest number of unfilled pods with a mean of 34. Figure 12 shows the average seed yield per plant. ICCV 92311 that were weed free from sowing to harvesting had the highest yield per plant with a mean of 102.5g while ICCV 94954 those that were weed free from sowing to seedling stage had the lowest yield per plant with a mean of only 12.06g. Figure 13 shows the total yield per 1x3m plot. ICCV 92311 that were weed free from sowing to harvesting had the highest yield per 1x3m plot with a mean of 709.7g while ICCV 94954 those that were weed free plants from sowing to seedling stage had the lowest yield per plot with only 111g. Figure 14 shows the



computed yield per hectare. ICCV 92311 weed free from sowing to harvesting had the highest yield per hectare with a mean of 2365.6kg while ICCV 94954 that were weed free from sowing to seedling stage had the lowest yield per hectare with a mean of only 368kg. Figure 15 shows the weight of 100 seeds. ICCV 07307 that were weed free from sowing to seedling stage had the heaviest weight of 100 seeds with a mean of 38.1g while ICCV 94954 those that were weed free from sowing to first flowering stage had lightest weight of 100 seeds with a mean of only 19.0g.

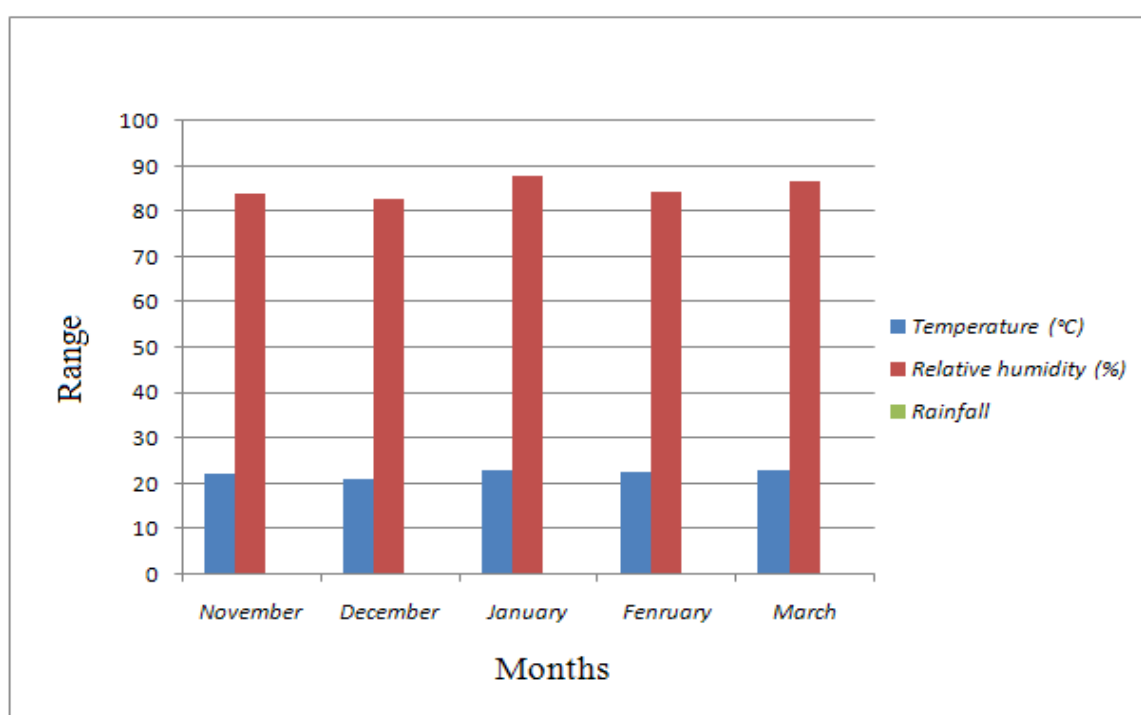


Figure 1. Recorded temperature, relative humidity and rainfall during the duration of the Study





Figure 2. Land preparation of the experimental area



Figure 3. Sowing of the seeds







Figure 4. Kabuli type chickpea at flowering stage



Figure 5. Overview of the experiment



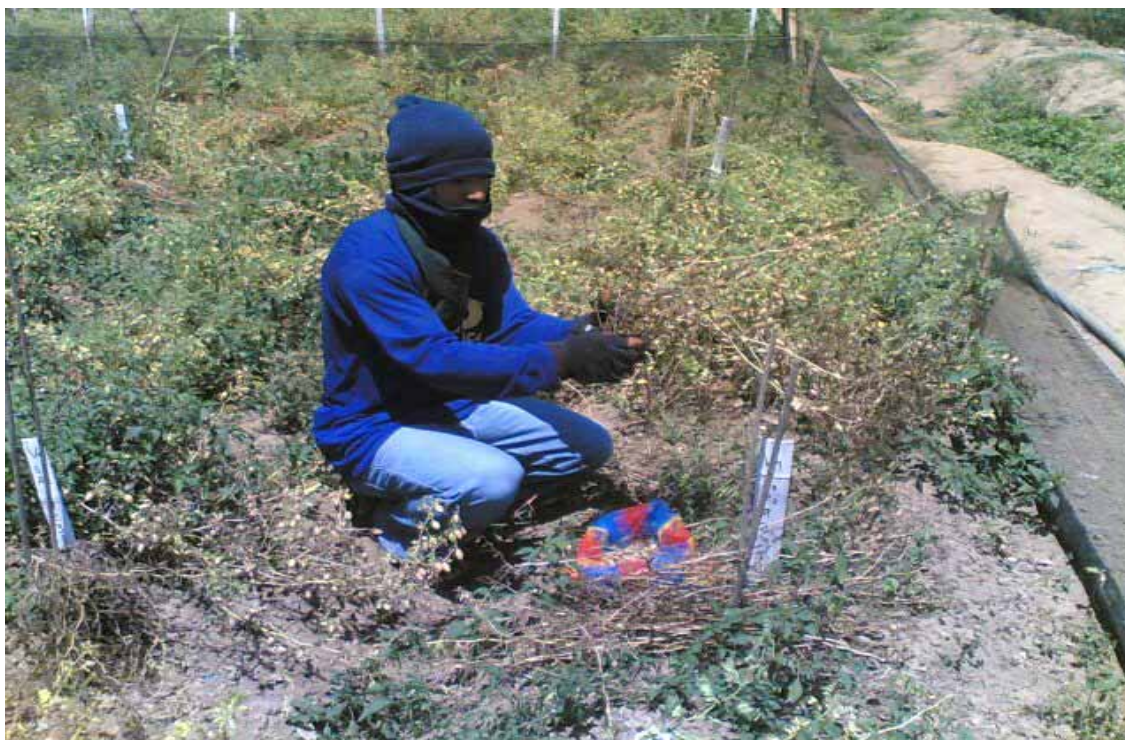


Figure 6. Harvesting of Seeds





## RESULTS AND DISCUSSION

### Days From Planting to 50% Flowering

Effect of variety. The days from planting to 50% flowering was significantly affected by the different varieties used. The Kabuli type chickpea as shown in Table 1 significantly flowered earlier than the Desi type variety. Apparently, the plants of ICCV 92311 a Kabuli type variety were the earliest to attain 50% flowering after 57.58 days, while the plants of ICCV 93952 a Desi type variety were the latest to attain 50% flowering after 71 days from sowing the seeds

Environment factors like temperature certainly contributed to the duration of the flowering in chickpea. Flowering time of chickpea is variable depending on the season, sowing date, latitude and altitude. The time to flowering is likewise affected by temperature and photoperiod.

Effect of weed control duration. The number of days from planting to 50% flowering was significantly affected by the different duration of weed control. As shown in Table 1, chickpea that were weed free from sowing to first pod stage reached flowering significantly the earlier with a mean of 62.89; compared to plants that were weed free from sowing to seedling stage which were the latest to attain 50% flowering after 65.44 days.

Interaction effect. Significant interaction effect was observed on the days from planting to 50% flowering as affected by the variety and the duration of weed control used. ICCV 92311 that were weed free from sowing to first pod stage were the earliest to attain 50% flowering after 57.33 days; while ICCV 93952 that were weed free from sowing to seedling stage flowered the latest after 72.33 days (Figure 7).



Table 1. Days from planting to 50% flowering

| TREATMENT                                      | MEAN                |
|--|---------------------|
| Variety  |                     |
| ICCV 93952                                     | 71.00 <sup>a</sup>  |
| ICCV 94954                                     | 69.25 <sup>a</sup>  |
| ICCV 06102                                     | 66.00 <sup>b</sup>  |
| ICCV 92311                                     | 57.58 <sup>d</sup>  |
| ICCV 95334                                     | 57.75 <sup>d</sup>  |
| ICCV 07307                                     | 63.17 <sup>c</sup>  |
| Duration of weed control                       |                     |
| Weed free from sowing to seedling stage        | 65.44 <sup>a</sup>  |
| Weed free from sowing to first flowering stage | 64.22 <sup>ab</sup> |
| Weed free from sowing to first pod stage       | 62.89 <sup>b</sup>  |
| Weed free from sowing to harvesting (ICRISAT)  | 63.94 <sup>ab</sup> |
| CV (%)   | 03.97               |

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

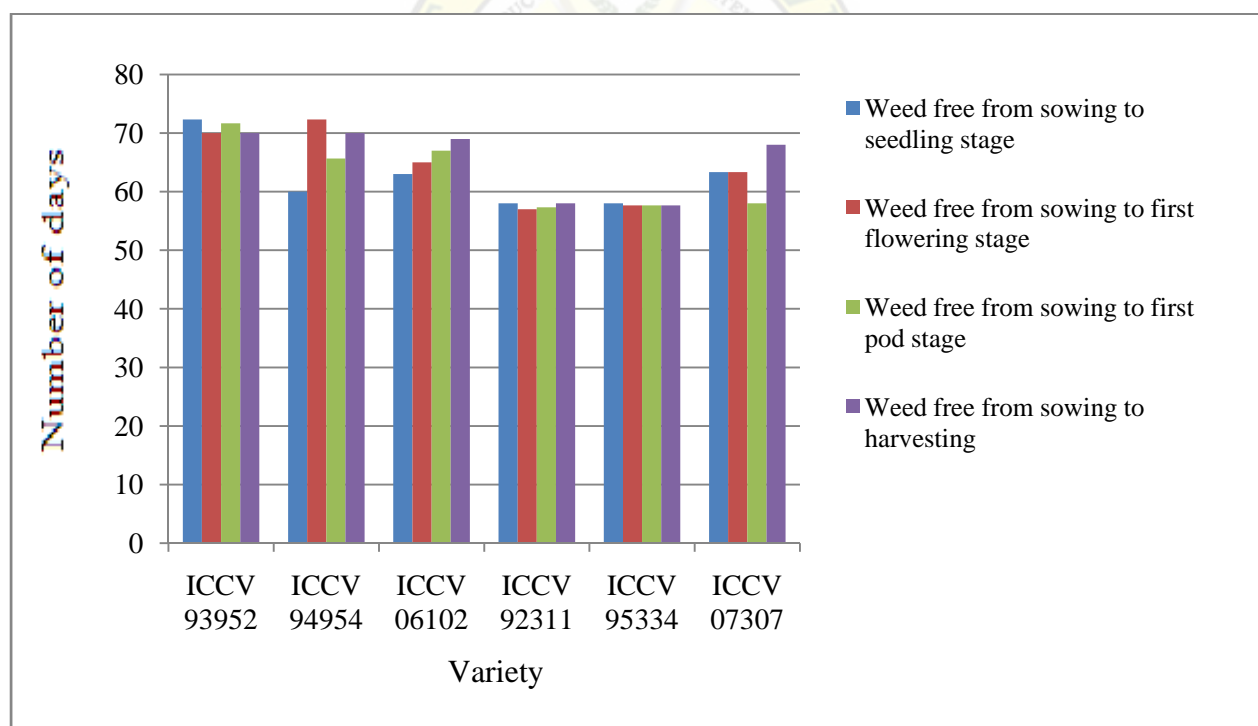


Figure 7. Number of days from planting to 50% flowering



### Average Plant Height at Flowering

Effect of variety. Significant differences were observed on the average plant height at flowering as affected by the different varieties used. As shown in Table 2, ICCV 95334 a Kabuli type cultivar were the tallest plants at flowering with a mean of 58.20cm while ICCV 94954 a Desi type cultivar were the shortest plants with a mean of 42.28cm.

The observed differences among the chickpea varieties may be attributed to their differential adaptability to local conditions as well as their inherent height potential.

Effect of weed control duration. There were no significant differences noted on the average plant height at flowering as affected by the different durations of weed control. Weed free plants from sowing to harvesting however, had taller plants at flowering with a mean of 49.98cm. Weed free plants from sowing to first flowering stage had smaller plants with a mean of 48.14cm.

Table 2. Average plant height at flowering (cm)

| TREATMENT                                      | MEAN                |
|--|---------------------|
| Variety  |                     |
| ICCV 93952                                     | 48.78 <sup>bc</sup> |
| ICCV 94954                                     | 42.22 <sup>d</sup>  |
| ICCV 06102                                     | 45.94 <sup>cd</sup> |
| ICCV 92311                                     | 52.04 <sup>b</sup>  |
| ICCV 95334                                     | 58.20 <sup>a</sup>  |
| ICCV 07307                                     | 46.38 <sup>cd</sup> |
| Duration of weed control                       |                     |
| Weed free from sowing to seedling stage        | 46.38 <sup>cd</sup> |
| Weed free from sowing to first flowering stage | 48.14 <sup>a</sup>  |
| Weed free from sowing to first pod stage       | 49.64 <sup>a</sup>  |
| Weed free from sowing to harvesting (ICRISAT)  | 49.48 <sup>a</sup>  |
| CV (%)   | 11.43               |

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





Interaction effect. Figure 8 show that there were significant interaction effects observed between the variety and the different durations of weed control with regards to plant height at flowering. However results show that ICCV 95334 that were weed free from sowing to first pod stage were the tallest plants at flowering with 58.83 cm while ICCV 94954 that were weed free from sowing first flowering stage had the shortest plants of 38.93 cm at flowering stage.

### Number of Primary Stems at Flowering

Effect of variety. There were significant differences observed on the number of primary stems produced at flowering as affected by the different varieties used. ICCV 92311 had highest number of primary stems with a mean of 3.67 while ICCV 07307 had the lowest with a mean of 2.17 stems per plant. The other varieties grown had comparable number of primary stems produced per plant.

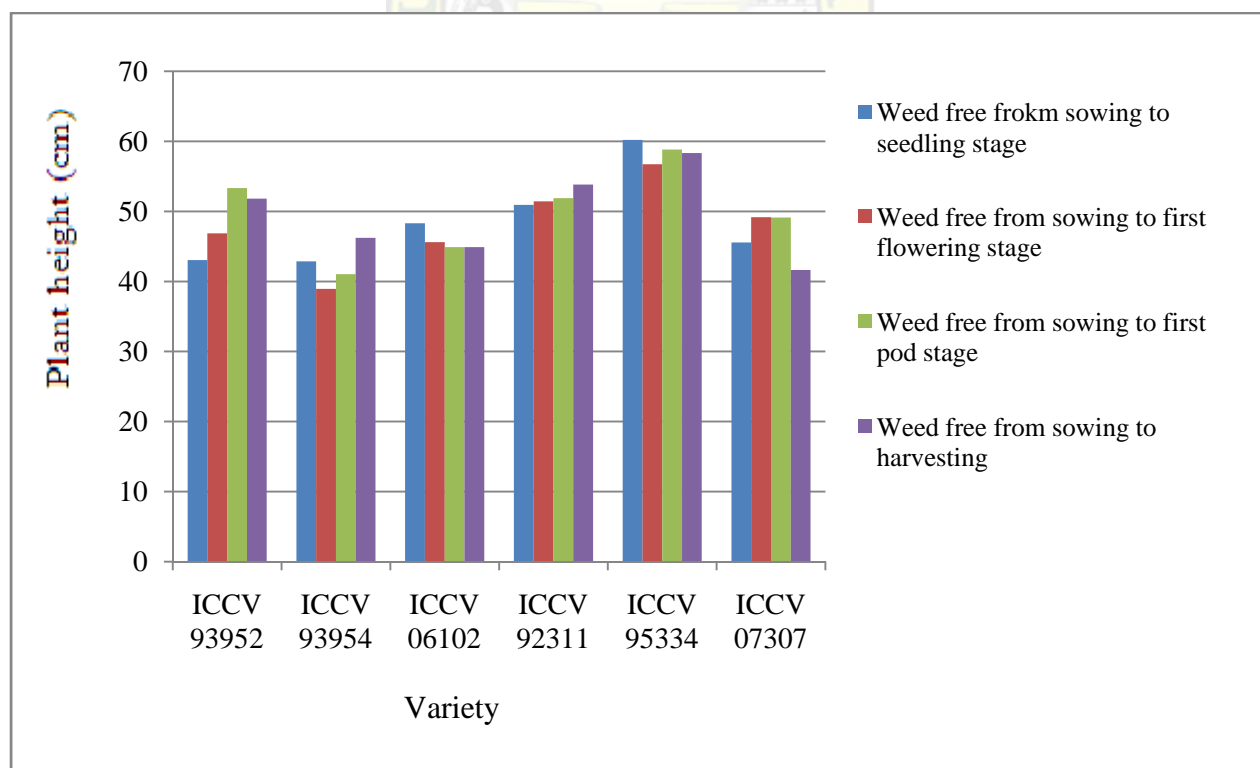


Figure 8. Average plant height at flowering



Effect of weed control duration. There were no significant differences observed on the number of primary stems at flowering as affected by the different durations of weed control. However, weed free plants from sowing to seedling stage had the highest number of primary stems at flowering with a mean of 3.22 while those plants that were weed free from sowing to harvesting had the least with a mean of 2.28.

Chickpea is a herbaceous annual plant which branches from the base. It is almost a small bush with diffused spreading branches. The plant is mostly covered with glandular and non glandular hairs but some genotypes do not possess hair.

Interaction effect. Statistical analysis revealed that there were no significant interaction effects between the varieties and the different durations of weed control used in the study with regards to number of primary stems produced per plant at flowering.

Table 3. Average number of primary stems at flowering

| TREATMENT                                      | MEAN              |
|--|-------------------|
| Variety  |                   |
| ICCV 93952                                     | 3.17 <sup>a</sup> |
| ICCV 94954                                     | 2.50 <sup>b</sup> |
| ICCV 06102                                     | 3.58 <sup>a</sup> |
| ICCV 92311                                     | 3.67 <sup>a</sup> |
| ICCV 95334                                     | 3.42 <sup>a</sup> |
| ICCV 07307                                     | 2.17 <sup>b</sup> |
| Duration of weed control                       |                   |
| Weed free from sowing to seedling stage        | 3.22 <sup>a</sup> |
| Weed free from sowing to first flowering stage | 3.17 <sup>a</sup> |
| Weed free from sowing to first pod stage       | 3.11 <sup>a</sup> |
| Weed free from sowing to harvesting (ICRISAT)  | 2.28 <sup>a</sup> |
| CV (%)   | 22.22             |

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



### Days From Planting to Harvesting

Effect of variety. The number of days from planting to harvesting was significantly affected by the different varieties used in the study. As shown in table 4, seeds plants of ICCV 07307 a Kabuli type cultivar were the earliest to be harvested after 120 days from sowing seeds, while seeds plants of ICCV 06102 a Desi type cultivar were the latest that were harvested after 145 days from sowing seeds.

Chickpeas mature in 3-7 months and the leaves turn brown/yellow during maturity. The seeds from plants were harvested at maturity or slightly earlier by cutting them close to the ground.

Effect of weed control duration. There were no significant differences observed on the days from planting to harvesting as affected by the different durations of weed control.

Interaction effect. Likewise, there were no significant interaction effects observed on the days from planting to harvesting as affected by the variety and the durations of weed control.

### Average Total Number of Pods per Plant

Effect of variety. Significant differences were observed on the average total number of pods per plant as affected by the different varieties used. ICCV 92311 a Kabuli type cultivar had the highest average total number of pods per plant with a mean of 311.33; while ICCV 94954 a Desi type cultivar had the lowest average total number of pods per plant with a mean of 132.50. It was observed that the Kabuli type cultivars grown produced more pods per plant than the Desi type cultivar tested.

Effect of weed control duration. Result shows that there were significant differences on the average total number of pods per plant as affected by the different durations of weed control.



Table 4. Number of days from planting to harvesting

| TREATMENT                                      | MEAN               |
|--|--------------------|
| Variety  |                    |
| ICCV 93952                                     | 136.0 <sup>a</sup> |
| ICCV 94954                                     | 140.0 <sup>b</sup> |
| ICCV 06102                                     | 145.0 <sup>a</sup> |
| ICCV 92311                                     | 122.0 <sup>c</sup> |
| ICCV 95334                                     | 125.0 <sup>d</sup> |
| ICCV 07307                                     | 120.0 <sup>f</sup> |
| Duration of weed control                       |                    |
| Weed free from sowing to seedling stage        | 131.3 <sup>a</sup> |
| Weed free from sowing to first flowering stage | 131.3 <sup>a</sup> |
| Weed free from sowing to first pod stage       | 131.3 <sup>a</sup> |
| Weed free from sowing to harvesting (ICRISAT)  | 131.3 <sup>a</sup> |
| CV (%)   | 0                  |

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

Weed free plants from sowing to harvesting produced the highest average total number of pods per plant with a mean of 223.22; while weed free plants from sowing to seedling stage produced the lowest average total number of pods per plant with a mean of only 170.61.

The trend on the average total number of pods produced per plant was observed as affected by the different durations of weed control shows that as the weeds were removed on every stage of the plant growth, the number of pods per plant increased. It was also observed that the competition between the plants and the weeds was lowered as the weeding activity was done regularly.

Interaction effect. There were significant interaction effects observed on the average total number of pods per plant as affected by the variety and the durations of weed control. ICCV 92311 that were weed free from sowing to harvesting produced the highest number of pods per plant with a mean of 337.66; while ICCV 94954 that were weed free from sowing to seedling stage produced the lowest number of pods with only 58 per plant (Figure 9).



Table 5. Total number of pods per plant

| TREATMENT                                      | MEAN                 |
|--|----------------------|
| Variety  |                      |
| ICCV 93952                                     | 264.92 <sup>b</sup>  |
| ICCV 94954                                     | 132.50 <sup>c</sup>  |
| ICCV 06102                                     | 205.50 <sup>c</sup>  |
| ICCV 92311                                     | 311.33 <sup>c</sup>  |
| ICCV 95334                                     | 175.81 <sup>d</sup>  |
| ICCV 07307                                     | 199.58 <sup>c</sup>  |
| Duration of weed control                       |                      |
| Weed free from sowing to seedling stage        | 170.61 <sup>c</sup>  |
| Weed free from sowing to first flowering stage | 208.83 <sup>ab</sup> |
| Weed free from sowing to first pod stage       | 202.83 <sup>b</sup>  |
| Weed free from sowing to harvesting (ICRISAT)  | 223.22 <sup>a</sup>  |
| CV (%)   | 12.52                |

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

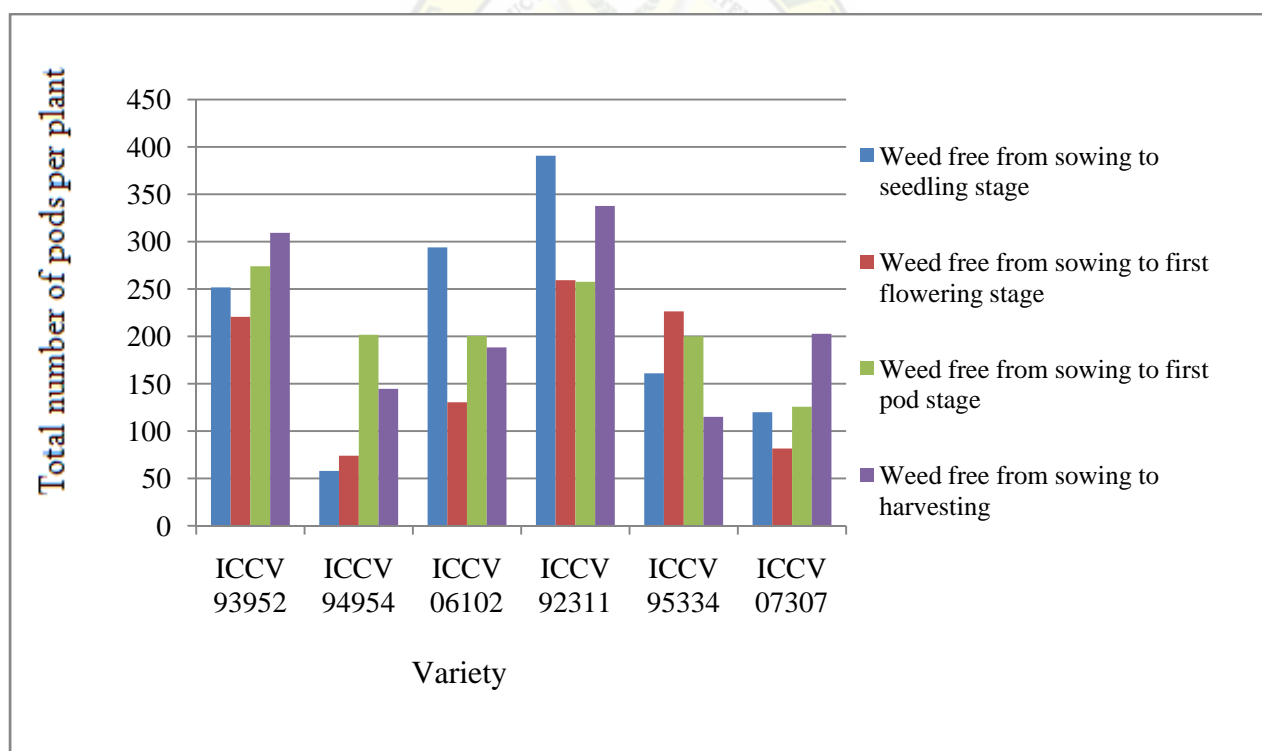


Figure 9. Average total number of pods per plant



### Average Number of Filled Pods per Plant

Effect of variety. Results show significant differences on the average number of filled pods per plant as affected by the different varieties used. ICCV 92311 produced the highest number of filled pods having a mean of 286.05 per plant while ICCV 94954 produced the lowest number of filled pods having a mean of only 106.99 per plant.

Effect of weed control duration. There were also significant differences observed on the average number of filled pods as affected by the different durations of weed control. Weed free plants from sowing to harvesting obtained the highest number of filled pods with a mean of 203.37 per plant while weed free plants from sowing to seedling stage produced the lowest number of filled pods with a mean of 151.18 per plant.

Interaction effect. Significant interaction effects were likewise, observed on the average number of filled pods between the variety and the different durations of weed control. (Figure 10) ICCV 92311 plants that were weed free from sowing to harvesting had the highest number of filled pods per plant with a mean of 349.99; while ICCV 94954 plants that were weed free from sowing to seedling stage had the lowest number of filled pods of only 48.77.



Table 6. Average number of filled pods per plant

| TREATMENT                                      | MEAN                |
|--|---------------------|
| Variety  |                     |
| ICCV 93952                                     | 239.66 <sup>a</sup> |
| ICCV 94954                                     | 106.99 <sup>b</sup> |
| ICCV 06102                                     | 181.47 <sup>a</sup> |
| ICCV 92311                                     | 286.80 <sup>a</sup> |
| ICCV 95334                                     | 156.05 <sup>b</sup> |
| ICCV 07307                                     | 110.44 <sup>b</sup> |
| Duration of weed control                       |                     |
| Weed free from sowing to seedling stage        | 151.18 <sup>c</sup> |
| Weed free from sowing to first flowering stage | 180.18 <sup>b</sup> |
| Weed free from sowing to first pod stage       | 185.49 <sup>b</sup> |
| Weed free from sowing to harvesting (ICRISAT)  | 203.37 <sup>a</sup> |
| CV (%)   | 12.03               |

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

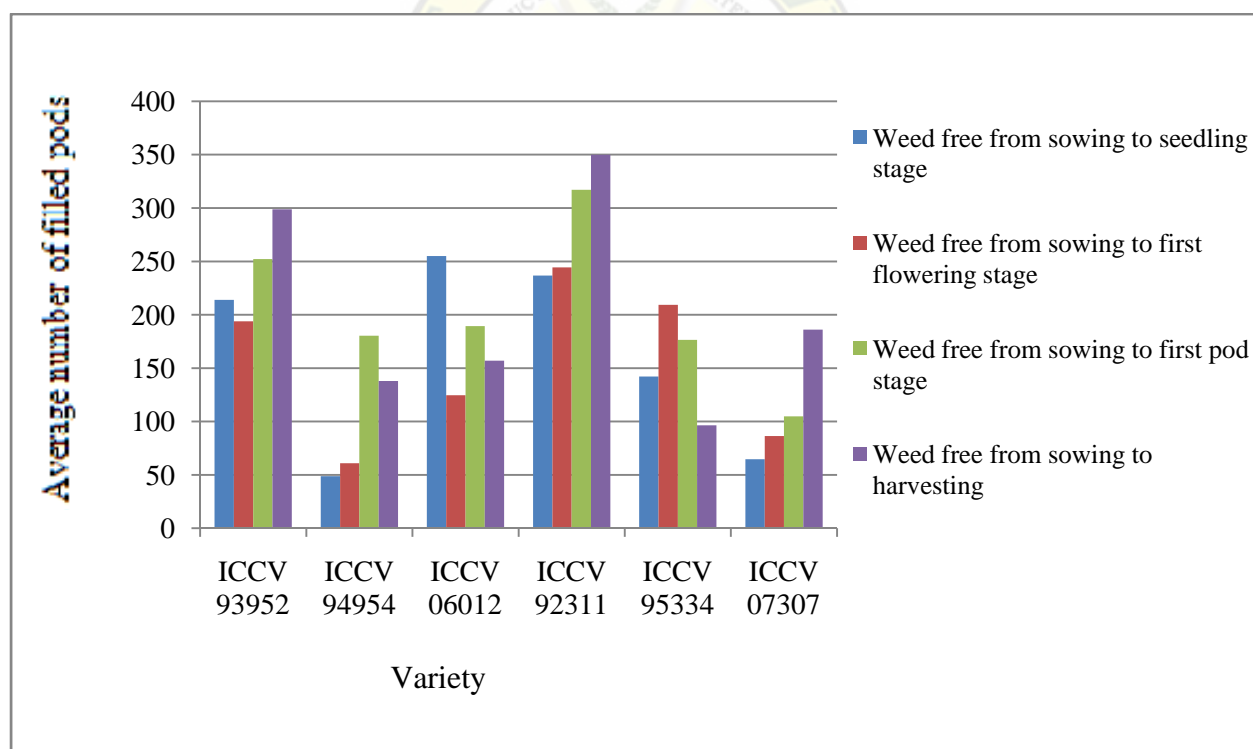


Figure 10. Average number of filled pods per plant



### Average Number of Unfilled Pods per Plant

Effect of variety. Table 6 shows significant differences on the average number of unfilled pod per plant as affected by the chickpea varieties used. ICCV 94954 produced the lowest number of unfilled pods having a mean of only 13.50 per plant; while ICCV 06102 and ICCV 92311 produced the highest number of unfilled pods having a mean of 24.75 per plant. These results may be due to the differential response of the various chickpea cultivars to the existing environment of the locality during the cropping period.

Effect of weed control duration. There were significant differences on the average number of unfilled pods produced per plant as affected by the different durations of weed control. Weed free plants from sowing to first pod stage had the lowest number of filled pods with a mean of 18.06; while weed free plants from sowing to first flowering stage had the highest number of unfilled pods with a mean of 28.22.

Interaction effect. Likewise significant interaction effects were observed on the number of unfilled pods between the chickpea varieties variety and the different durations of weed control. ICCV 94954 weed free plants from sowing to first flowering stage had the lowest number of unfilled pods with a mean of only 13.16; while ICCV 06102 those that were also weed free plants from sowing to first flowering stage had the highest number of unfilled pods with a mean of 34 (Figure 11).





Table 7. Average number of unfilled pods

| TREATMENT                                      | MEAN                |
|--|---------------------|
| Variety  |                     |
| ICCV 93952                                     | 24.50 <sup>a</sup>  |
| ICCV 94954                                     | 13.50 <sup>b</sup>  |
| ICCV 06102                                     | 24.75 <sup>a</sup>  |
| ICCV 92311                                     | 24.75 <sup>a</sup>  |
| ICCV 95334                                     | 19.83 <sup>ab</sup> |
| ICCV 07307                                     | 22.42 <sup>ab</sup> |
| Duration of weed control                       |                     |
| Weed free from sowing to seedling stage        | 20.06 <sup>ab</sup> |
| Weed free from sowing to first flowering stage | 28.22 <sup>a</sup>  |
| Weed free from sowing to first pod stage       | 18.06 <sup>b</sup>  |
| Weed free from sowing to harvesting (ICRISAT)  | 20.17 <sup>b</sup>  |
| CV (%)   | 55.97               |

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

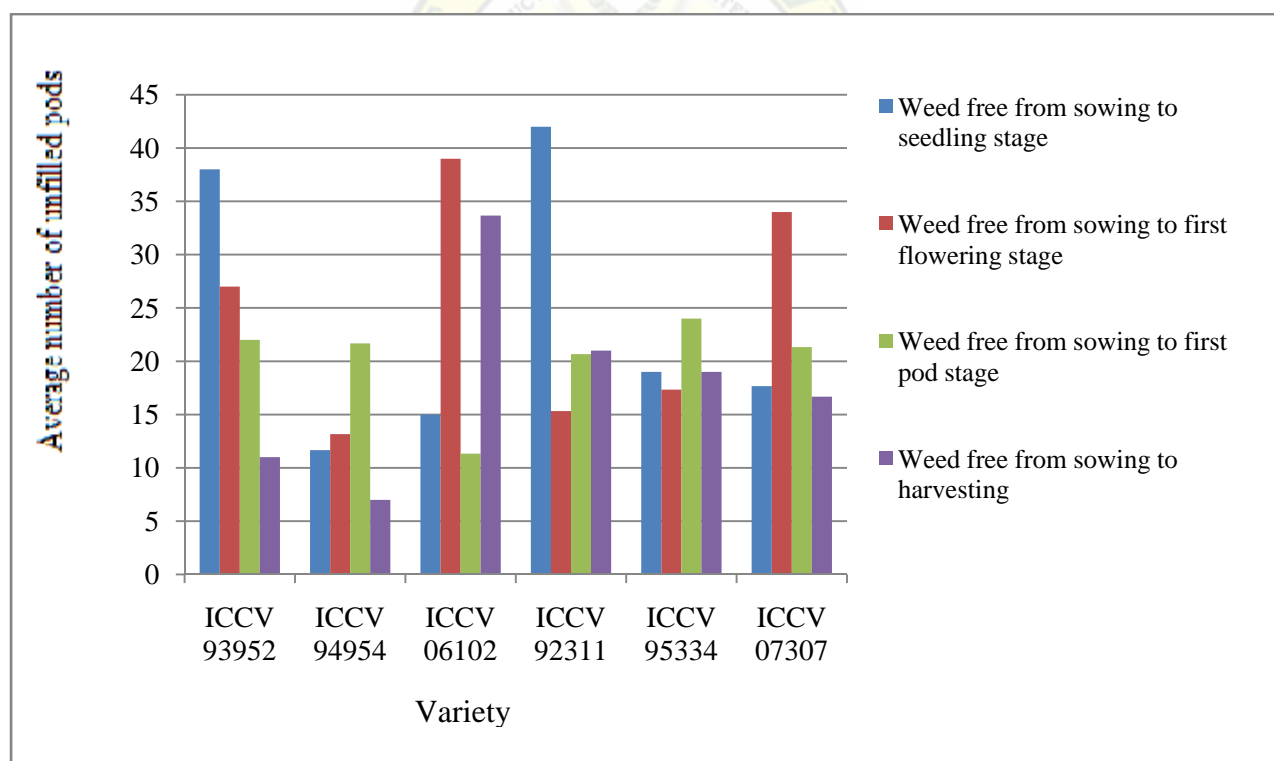


Figure 11. Average number of unfilled pods



### Average Seed Yield per Plant (g)

Effect of variety. The average seed yield per plant was significantly affected by the different chickpea varieties used in the study. ICCV 95334 produced the highest yield per plant with a mean of 72.81g; while ICCV 94954 obtained the lowest yield per plant with a mean of only 28.25g.

Chickpea is a long season crop, thus delay in plant establishment will likely reduce the length of time for pod filling, and seed germination.

Effect of weed control duration. Significant differences were likewise observed on the average seed yield per plant as affected by the different durations of weed control. Weed free plants from sowing to harvesting had the highest yield per plant with a mean of 69.34g; while weed free plants from sowing to seedling stage had the lowest yield per plant with a mean of only 45.50g.

The trend on the average seed yield per plant was observed as affected by the duration of weed control on the different stages of the plant was that, the yield per plant was increased as the weeds were removed and the competition between the plants and the weeds was also lowered.

Interaction effect. Significant interaction effects were observed on the average seed yield per plant on the chickpea varieties and durations of weed control used. ICCV 92311 that were weed free plants from sowing to harvesting had the highest yield per plant with a mean of 102.5g; while ICCV 94954 those that were weed free plants from sowing to seedling stage had the lowest yield per plant with a mean of only 12.06g.



Table 8. Average seed yield per plant

| TREATMENT                                      | MEAN               |
|--|--------------------|
| Variety  |                    |
| ICCV 93952                                     | 70.43 <sup>a</sup> |
| ICCV 94954                                     | 28.25 <sup>b</sup> |
| ICCV 06102                                     | 69.54 <sup>a</sup> |
| ICCV 92311                                     | 72.81 <sup>a</sup> |
| ICCV 95334                                     | 70.16 <sup>a</sup> |
| ICCV 07307                                     | 67.25 <sup>b</sup> |
| Duration of weed control                       |                    |
| Weed free from sowing to seedling stage        | 45.50 <sup>b</sup> |
| Weed free from sowing to first flowering stage | 48.32 <sup>b</sup> |
| Weed free from sowing to first pod stage       | 67.25 <sup>a</sup> |
| Weed free from sowing to harvesting (ICRISAT)  | 69.34 <sup>a</sup> |
| CV (%)   | 14.48              |

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

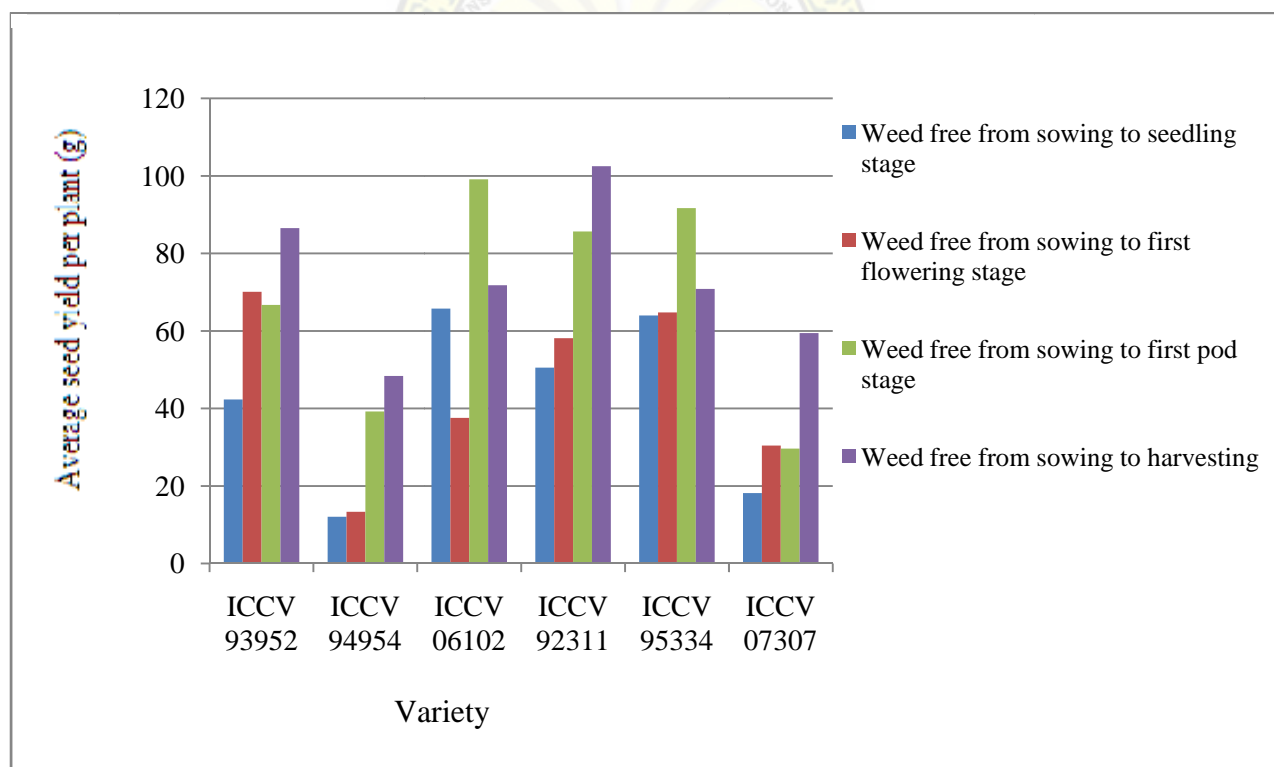


Figure 12. Average seed yield per plant (g)



### Total Yield per 1x3m Plot (g)

Effect of variety. As presented in Table 8, significant differences were noted on the total yield per plot as affected by the different varieties used. ICCV 92311 had the highest yield per 1x3m plot with a mean of 539.82g, while ICCV 94954 had the lowest yield per 1x3m plot with a mean of only 152.45g.

Effect of weed control duration. Result shows that there were significant differences on the yield per plot as affected by the different durations of weed control. Weed free plants from sowing to harvesting had the highest yield per plot with a mean of 430.23g, while weed free plants from sowing to seedling stage had the lowest yield per plot with a mean of 276.88g.

The trend on the total yield per plot was observed as affected by the duration of weed control on the different stages of the plant that the yield was increased as the weeds were continued to be removed regularly until harvesting of seeds. Competition among the plants and the weeds was also lowered.

Interaction effect. There were also significant interaction effects among the chickpea varieties and the durations of weed control used. ICCV 92311 that were weed free plants from sowing to harvesting had the highest yield per 1x3m plot with a mean of 709.7g, while ICCV 94954 those that were weed free plants from sowing to seedling stage had the lowest yield per plot of only 111g (Figure 13).



Table 9. Total yield per 1x3m plot

| TREATMENT                                      | MEAN                |
|--|---------------------|
| Variety  |                     |
| ICCV 93952                                     | 452.82 <sup>a</sup> |
| ICCV 94954                                     | 152.45 <sup>c</sup> |
| ICCV 06102                                     | 321.93 <sup>c</sup> |
| ICCV 92311                                     | 539.98 <sup>a</sup> |
| ICCV 95334                                     | 420.08 <sup>b</sup> |
| ICCV 07307                                     | 193.57 <sup>d</sup> |
| Duration of weed control                       |                     |
| Weed free from sowing to seedling stage        | 276.88 <sup>c</sup> |
| Weed free from sowing to first flowering stage | 315.48 <sup>b</sup> |
| Weed free from sowing to first pod stage       | 424.64 <sup>a</sup> |
| Weed free from sowing to harvesting (ICRISAT)  | 430.23 <sup>a</sup> |
| CV (%)   | 10.82               |

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

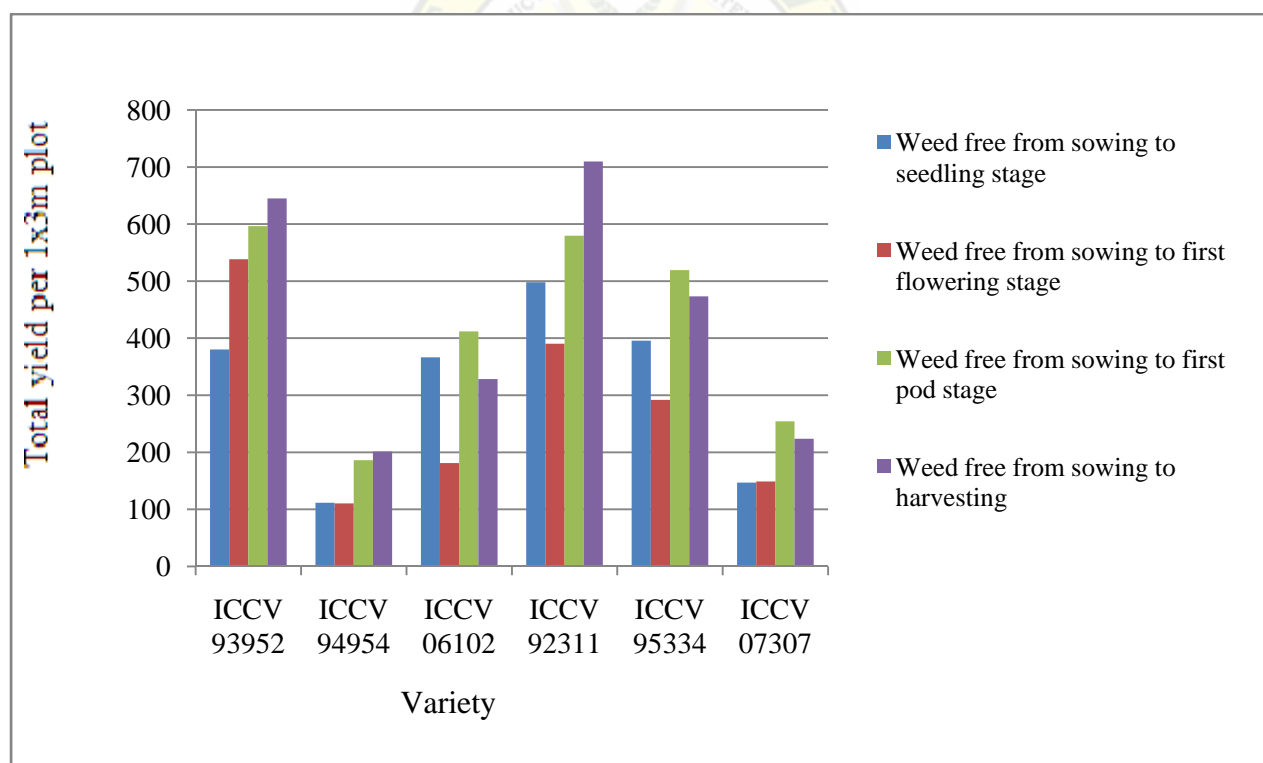


Figure 13. Total yield per 1x3m plot



### Computed Yield per Hectare (kg/ha)

Effect of variety. The computed yield per hectare was significantly affected by the different varieties studied. ICCV 92311 had the highest yield per hectare with a mean of 1809.33kg while ICCV 94954 had the lowest yield per hectare with a mean of 508.98kg.

Effect of weed control duration. The different durations of weed control showed significant differences on the computed yield per hectare. Weed free plants from sowing to harvesting had the highest yield per hectare with a mean of 1434 kg, while weed free plants from sowing to seedling stage had the lowest yield per hectare with a mean of 922.90kg.

The trend on the total yield per hectare was observed as affected by the duration of weed control on the different stages of the plant that as the weeding activity was done on regular basis, the yield was increased until harvesting. The competition between the plants and the weeds was also lowered.

Chickpea yields usually average 400 – 600 kg/ha, but can surpass 2000 kg/ha. Yields from irrigated crops are 20-28 % higher than rain fed crops.

Interaction effect. Figure 14 shows that there were significant interaction effects observed on the computed yield per hectare as affected by the chickpea varieties and the durations of weed control. ICCV 92311 weed free from sowing to harvesting had the highest yield per hectare with a mean of 2365.6kg while ICCV 94954 that were weed free from sowing to seedling stage had the lowest yield per hectare with a mean of only 368kg.



Table 10. Computed yield per hectare (kg/ha)

| TREATMENT                                      | MEAN                 |
|--|----------------------|
| Variety  |                      |
| ICCV 93952                                     | 1799.89 <sup>a</sup> |
| ICCV 94954                                     | 0508.16 <sup>c</sup> |
| ICCV 06102                                     | 1073.07 <sup>c</sup> |
| ICCV 92311                                     | 1809.33 <sup>a</sup> |
| ICCV 95334                                     | 1400.24 <sup>b</sup> |
| ICCV 07307                                     | 645.20 <sup>d</sup>  |
| Duration of weed control                       |                      |
| Weed free from sowing to seedling stage        | 922.90 <sup>c</sup>  |
| Weed free from sowing to first flowering stage | 1051.57 <sup>b</sup> |
| Weed free from sowing to first pod stage       | 1415.41 <sup>a</sup> |
| Weed free from sowing to harvesting (ICRISAT)  | 1434.04 <sup>a</sup> |
| CV (%)   | 10.82                |

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

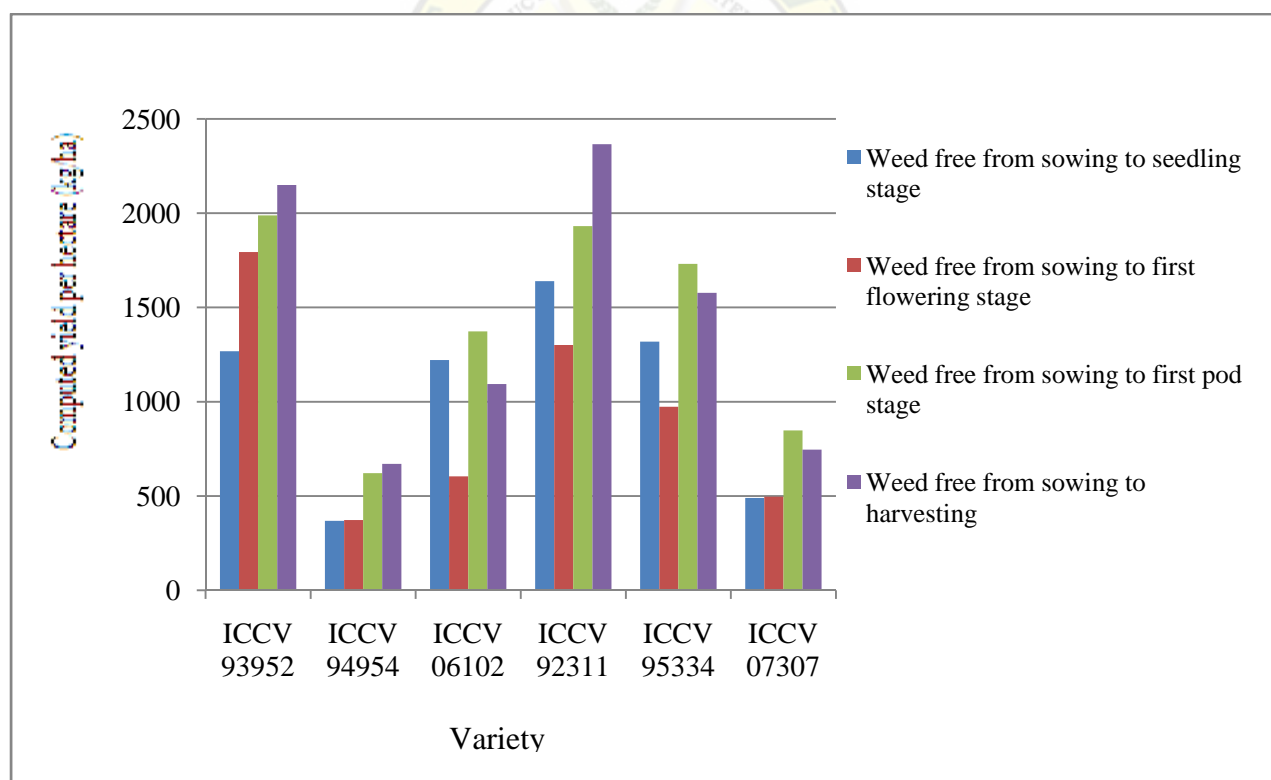


Figure 14. Computed yield per hectare



### Weight of 100 Seeds

Effect of variety. There were significant differences observed on the weight of 100 seeds as affected by the different chickpea varieties used. Large seeded Kabuli type ICCV 07307 had the highest weight of 100 seeds with a mean of 38.28g, while small seeded Desi type ICCV 94954 had the lowest weight of 100 seeds with a mean of 20.38g.

Results indicate that the seed weight depends on the seed size. The bigger the seed, the heavier the weight and the smaller it is, the lower the weight.

Singh (1987) stated that in Poland, minimum Kabuli type seed weight of 100g is about 49.5g especially on the large seeded Kabuli chickpea, whereas Desi type, small seeded cultivars have a minimum weight of 24.5g per 100 seeds.

Effect of weed control duration. Results show significant differences on the weight of 100 seeds as affected by the different durations of weed control. Weed free plants from sowing to seedling stage had the heaviest weight of 100 seeds with a mean of 28.86g, while weed free plants from sowing to first flowering stage and weed free plants from sowing to harvesting had the lightest weight of 100 seeds with a the same mean of 28.04g.

Interaction effect. Significant interaction effects were likewise observed between the chickpea varieties and durations of weed control. ICCV 07307 that were weed free from sowing to seedling stage had the heaviest weight of 100 seeds with a mean of 38.1g, while ICCV 94954 those that were weed free from sowing to first flowering stage had the lightest weight of 100 seeds with a mean of 19.0g.





Table 11. Weight of 100 seeds

| TREATMENT                                      | MEAN               |
|--|--------------------|
| Variety  |                    |
| ICCV 93952                                     | 22.63 <sup>c</sup> |
| ICCV 94954                                     | 20.39 <sup>d</sup> |
| ICCV 06102                                     | 22.36 <sup>c</sup> |
| ICCV 92311                                     | 33.14 <sup>b</sup> |
| ICCV 95334                                     | 34.07 <sup>b</sup> |
| ICCV 07307                                     | 38.28 <sup>a</sup> |
| Duration of weed control                       |                    |
| Weed free from sowing to seedling stage        | 28.86 <sup>a</sup> |
| Weed free from sowing to first flowering stage | 28.04 <sup>a</sup> |
| Weed free from sowing to first pod stage       | 28.76 <sup>a</sup> |
| Weed free from sowing to harvesting (ICRISAT)  | 28.04 <sup>a</sup> |
| CV (%)   | 6.39               |

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

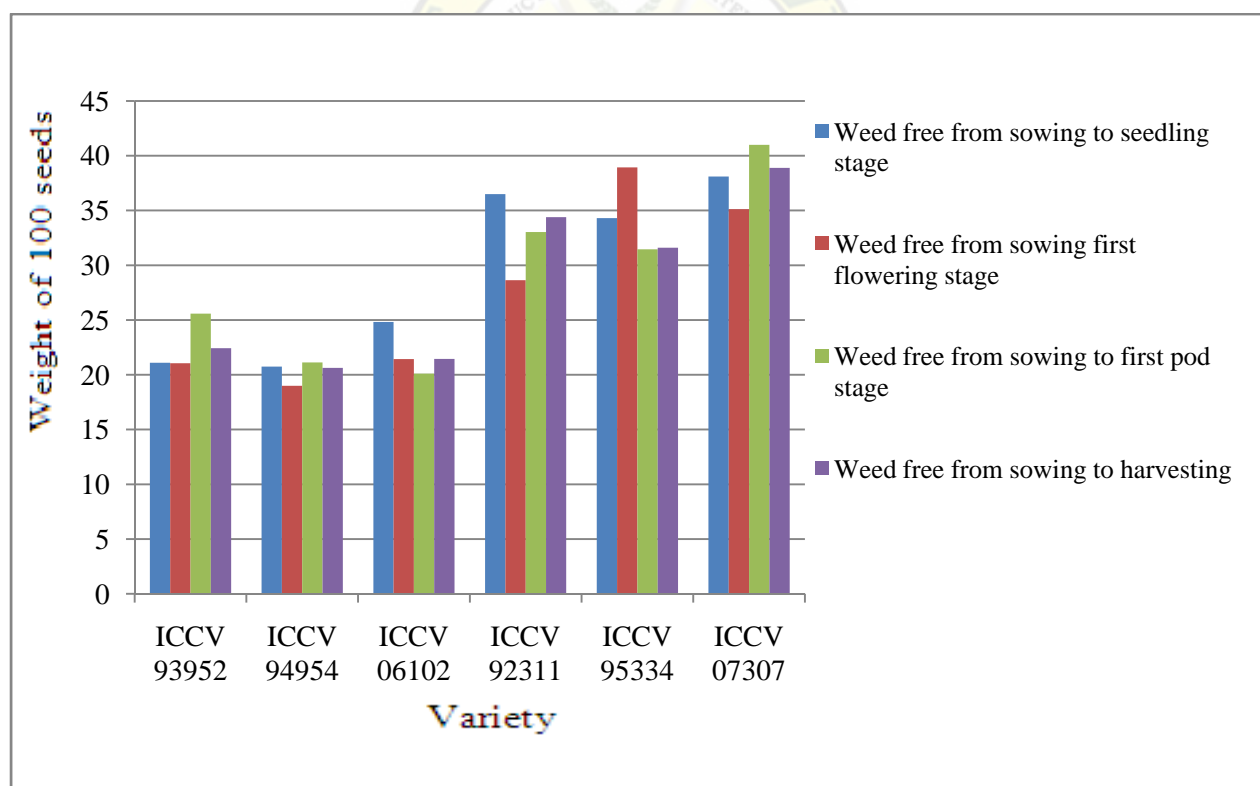


Figure 15. Weight of 100 seeds



Table 12. Common weeds grown in the experimental area

| COMMON NAME  | SCIENTIFIC NAME                |
|--------------|--------------------------------|
| Knot grass   | <i>Pennisetum pedicellatum</i> |
| Dallis grass | <i>Paspalum natatum</i>        |
| Gogon        | <i>Panicum capillare</i>       |
| Dukayang     | <i>Echinochloa crus-galli</i>  |
| Crab grass   | <i>Echinochloa colonum</i>     |
| Galinsoga    | <i>Galinsoga panviflora</i>    |
| Kalunay      | <i>Amaranthus</i>              |



## SUMMARY, CONCLUSION AND RECOMMENDATION

### Summary

The study was conducted to determine the growth and yield of different varieties of chickpea as affected by duration of weed control under La Trinidad Benguet Condition, determine the growth stage where yield will not be affected with the presence of weeds; and to determine the effect of weeds on the different growth stages of chickpea. The study was conducted from November to April 2010 at Benguet State University, La Trinidad Benguet.

Results showed significant differences between the two types of chickpea cultivars and the different durations of weed control employed. Kabuli type variety ICCV 95334 that were weed free from sowing to first pod stage were the earliest to attain 50% flowering; while Desi type variety ICCV 93952 that were weed free from sowing to harvesting took longer days to attain 50% flowering. For the average plant height at flowering, results showed significant differences between the chickpea varieties and the durations of weed control. Kabuli type variety ICCV 95334 that were weed free from sowing to harvesting were the tallest plants, while Desi type variety ICCV 94954 that were weed free from sowing to first flowering stage were the shortest plants at flowering. As to average number of primary stems at flowering, results showed no significant differences between the chickpea varieties and the durations of weed control. However, variety ICCV 92311 a Kabuli type had the highest number of primary stems at flowering, while ICCV 07307 a Kabuli type had the lowest number of primary stems at flowering.

Significant differences were likewise, observed between the chickpea varieties and durations of weed control on the total number of pods and average number of filled pods. ICCV 92311 that were weed free from sowing to harvesting produced the highest number of pods per



plant and average number of filled pods per plant while ICCV 94954 that were weed free from sowing to seedling stage had the lowest. ICCV 94954 that were weed free from sowing to first pod stage produced the lowest number of unfilled pods while ICCV 06102 and ICCV 95334 that were weed free from sowing to first flowering stage produced the highest number of unfilled pods per plant. Kabuli type variety ICCV 92311 that were weed free from sowing to harvesting produced the highest average seed yield per plant, total yield per 1x3m plot and computed yield per hectare; while Desi type variety ICCV 94954 that were weed free from sowing to seedling stage produced the lowest average seed yield per plant, yield per 1x3m plot and computed yield per hectare. ICCV 07307 a Kabuli type cultivar, had the heaviest weight of 100 seeds while ICCV 94954 a Desi type, had the lightest weight of 100 seeds.

### Conclusion

Based on the results presented and discussed, chickpea Desi and Kabuli type varieties are adopted La Trinidad Benguet condition. ICCV 95334 a Kabuli type cultivar were the tallest plant when grown weed free from sowing to harvesting. ICCV 92311 another Kabuli type produced the highest number of primary stems at flowering when grown weed free from sowing to seedling stage. ICCV 9231 that were weed free from sowing to harvesting produced the highest number of pods per plant and filled pods per plant. Desi type variety ICCV 94954 that were weed free from sowing to first pod stage produced the lowest number of unfilled pods per plant. ICCV 92311 that were weed free from sowing to harvesting produced the highest average seed yield per plant, total yield per 1x3m plot and computed yield per hectare. ICCV 07307 weed free from sowing to seedling stage were harvested the earliest after 120.0 days.



### Recommendation

Based on the findings of this study, it is therefore recommended that Desi type variety ICCV 93952 and Kabuli type ICCV 92311 should be grown weed free from sowing to harvesting which best suited under La Trinidad Benguet condition for higher yield per plant, and per hectare basis.



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## APPENDICES

Appendix Table 1. Days from planting to 50% flowering

| TREATMENT | REPLICATION |    |     | TOTAL  | MEAN  |
|-----------|-------------|----|-----|--------|-------|
|           | I           | II | III |        |       |
| V1 D1     | 73          | 73 | 71  | 219.00 | 72.33 |
| D2        | 63          | 73 | 69  | 210.00 | 70.00 |
| D3        | 71          | 73 | 71  | 215.00 | 71.66 |
| D4        | 69          | 73 | 68  | 210.00 | 70.00 |
| V2 D1     | 63          | 70 | 74  | 207.00 | 69.00 |
| D2        | 73          | 73 | 71  | 217.00 | 72.33 |



|       |    |    |    |        |       |
|-------|----|----|----|--------|-------|
| D3    | 67 | 66 | 64 | 131.66 | 65.67 |
| D4    | 73 | 73 | 64 | 210.00 | 70.00 |
| V3 D1 | 66 | 59 | 64 | 189.00 | 63.00 |
| D2    | 68 | 64 | 63 | 195.00 | 65.00 |
| D3    | 64 | 68 | 69 | 201.00 | 67.00 |
| D4    | 64 | 71 | 68 | 207.00 | 69.00 |
| V4 D1 | 58 | 58 | 58 | 174.00 | 58.00 |
| D2    | 57 | 57 | 57 | 171.00 | 57.00 |
| D3    | 57 | 57 | 58 | 172.00 | 57.33 |
| D4    | 58 | 58 | 58 | 174.00 | 58.00 |
| V5 D1 | 58 | 58 | 58 | 174.00 | 58.00 |
| D2    | 58 | 57 | 58 | 173.00 | 57.66 |
| D3    | 58 | 58 | 57 | 173.00 | 57.66 |
| D4    | 57 | 58 | 58 | 173.00 | 57.66 |
| V6 D1 | 68 | 64 | 58 | 190.00 | 63.33 |
| D2    | 68 | 64 | 58 | 190.00 | 63.33 |
| D3    | 58 | 58 | 58 | 174.00 | 58.00 |
| D4    | 68 | 68 | 68 | 204.00 | 68.00 |

## ANALYSIS OF VARIANCE

| SOURCE OF VARIANCE           | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN OF SQUARES | COMPUTED F | TABULAR F |      |
|------------------------------|--------------------|----------------|-----------------|------------|-----------|------|
|                              |                    |                |                 |            | 0.05      | 0.01 |
| Block                        | 2                  | 23.08          | 11.54           | 1.78       | 0.1794    |      |
| Variety (A)                  | 5                  | 1936.79        | 387.36          | 50.88*     | <.0001    |      |
| Duration of Weed Control (B) | 3                  | 59.59          | 19.87           | 3.07*      | 0.04      |      |
| AXB                          | 15                 | 234.82         | 15.65           | 2.42*      | 0.01      |      |
| Error                        | 46                 | 297.58         |                 |            |           |      |
| TOTAL                        | 71                 | 2551.88        |                 |            |           |      |

\* = Significant

Coefficient of Variation = 3.79

Appendix Tale 2. Average plant height at flowering (cm)

| TREATMENT | REPLICATION |      |      | TOTAL | MEAN  |
|-----------|-------------|------|------|-------|-------|
|           | I           | II   | III  |       |       |
| V1 D1     | 55.8        | 28.6 | 44.8 | 129.2 | 43.06 |
| D2        | 39.5        | 53.5 | 47.6 | 140.6 | 46.86 |
| D3        | 53.8        | 54.0 | 52.2 | 160.0 | 53.33 |
| D4        | 53.7        | 49.8 | 52.0 | 155.5 | 51.83 |
| V2 D1     | 44.0        | 42.1 | 42.5 | 128.6 | 42.86 |
| D2        | 51.0        | 35.0 | 30.8 | 116.8 | 38.93 |
| D3        | 39.2        | 43.6 | 40.3 | 123.1 | 41.03 |
| D4        | 45.2        | 50.7 | 42.8 | 138.7 | 46.23 |
| V3 D1     | 44.9        | 49.9 | 50.1 | 144.9 | 48.03 |



|       |      |      |      |       |       |
|-------|------|------|------|-------|-------|
| D2    | 42.5 | 51.7 | 42.8 | 137.0 | 45.06 |
| D3    | 46.6 | 44.3 | 43.8 | 134.7 | 44.09 |
| D4    | 53.1 | 37.1 | 44.5 | 134.7 | 44.09 |
| V4 D1 | 51.3 | 52.3 | 49.2 | 152.8 | 50.93 |
| D2    | 51.1 | 52.9 | 50.3 | 154.3 | 51.43 |
| D3    | 51.1 | 52.6 | 52.0 | 155.7 | 51.09 |
| D4    | 54.9 | 55.3 | 51.3 | 161.5 | 53.83 |
| V5 D1 | 55.3 | 62.8 | 62.5 | 180.6 | 60.02 |
| D2    | 54.5 | 57.1 | 58.6 | 170.2 | 56.73 |
| D3    | 62.5 | 53.0 | 60.1 | 175.6 | 58.83 |
| D4    | 57.8 | 53.6 | 63.6 | 175.0 | 58.33 |
| V6 D1 | 48.2 | 41.0 | 47.5 | 136.7 | 45.56 |
| D2    | 47.0 | 56.6 | 56.6 | 147.5 | 49.16 |
| D3    | 48.9 | 53.3 | 53.3 | 147.5 | 49.13 |
| D4    | 33.3 | 41.5 | 41.3 | 124.9 | 41.63 |

## ANALYSIS OF VARIANCE

| SOURCE OF VARIANCE           | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN OF SQUARES | COMPUTED F         | TABULAR F |       |
|------------------------------|--------------------|----------------|-----------------|--------------------|-----------|-------|
|                              |                    |                |                 |                    | 0.05      | 0.01  |
| Block                        | 2                  | 18.54          | 9.27            | 0.03               |           | 0.75  |
| Variety (A)                  | 5                  | 1865.97        | 373.19          | 11.92*             |           | <.001 |
| Duration of Weed Control (B) | 3                  | 28.732         | 9.58            | 0.31 <sup>ns</sup> |           | 0.82  |
| AXB                          | 15                 | 429.66         | 29.64           | 0.92*              |           | 0.55  |
| Error                        | 46                 | 1439.86        | 31.30           |                    |           |       |
| TOTAL                        | 71                 | 3782.86        |                 |                    |           |       |

\* = Significant

Coefficient of Variation = 11.43

Appendix Table 3. Number of primary stems at flowering

| TREATMENT | REPLICATION |    |     | TOTAL | MEAN |
|-----------|-------------|----|-----|-------|------|
|           | I           | II | III |       |      |
| V1 D1     | 2           | 2  | 4   | 08.00 | 2.66 |
| D2        | 4           | 4  | 4   | 12.00 | 4.00 |
| D3        | 2           | 3  | 3   | 08.00 | 2.66 |
| D4        | 3           | 3  | 4   | 10.00 | 3.33 |
| V2 D1     | 2           | 2  | 5   | 09.00 | 2.66 |
| D2        | 4           | 2  | 2   | 08.00 | 2.66 |
| D3        | 1           | 3  | 4   | 08.00 | 2.66 |
| D4        | 2           | 3  | 3   | 08.00 | 4.00 |
| V3 D1     | 4           | 4  | 4   | 12.00 | 3.66 |





|       |   |   |   |       |      |
|-------|---|---|---|-------|------|
| D2    | 3 | 4 | 4 | 11.00 | 2.33 |
| D3    | 4 | 4 | 4 | 12.00 | 3.66 |
| D4    | 3 | 2 | 2 | 07.00 | 4.00 |
| V4 D1 | 3 | 4 | 4 | 11.00 | 3.33 |
| D2    | 4 | 4 | 4 | 12.00 | 3.00 |
| D3    | 4 | 3 | 3 | 10.00 | 3.33 |
| D4    | 3 | 3 | 3 | 09.00 | 3.00 |
| V5 D1 | 4 | 3 | 3 | 10.00 | 3.33 |
| D2    | 3 | 3 | 3 | 09.00 | 3.33 |
| D3    | 4 | 3 | 3 | 10.00 | 2.00 |
| D4    | 4 | 3 | 3 | 10.00 | 2.00 |
| V6 D1 | 2 | 2 | 2 | 06.00 | 2.00 |
| D2    | 2 | 2 | 2 | 06.00 | 2.00 |
| D3    | 2 | 2 | 2 | 06.00 | 2.00 |
| D4    | 1 | 2 | 2 | 05.00 | 1.66 |

## ANALYSIS OF VARIANCE

| SOURCE OF VARIANCE           | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN OF SQUARES | COMPUTED F         | TABULAR F |      |
|------------------------------|--------------------|----------------|-----------------|--------------------|-----------|------|
|                              |                    |                |                 |                    | 0.05      | 0.01 |
| Block                        | 2                  | 3.08           | 1.54            | 3.29               | 0.0003    |      |
| Variety (A)                  | 5                  | 22.66          | 4.53            | 9.66*              | <.0001    |      |
| Duration of Weed Control (B) | 3                  | 1.66           | 0.53            | 1.14 <sup>ns</sup> | 0.34      |      |
| AXB                          | 15                 | 10.56          | 0.70            | 1.50 <sup>ns</sup> | 0.15      |      |
| Error                        | 46                 | 21.58          | 0.47            |                    |           |      |
| TOTAL                        | 71                 | 50.50          |                 |                    |           |      |

\* = Significant

Coefficient of Variation = 12.52

ns = Not significant

Appendix Table 4. Number of days from planting to harvesting

| TREATMENT | REPLICATION |     |     | TOTAL | MEAN |
|-----------|-------------|-----|-----|-------|------|
|           | I           | II  | III |       |      |
| V1 D1     | 136         | 136 | 136 | 408   | 136  |
| D2        | 136         | 136 | 136 | 408   | 136  |
| D3        | 136         | 136 | 136 | 408   | 136  |
| D4        | 136         | 136 | 136 | 408   | 136  |
| V2 D1     | 140         | 140 | 140 | 420   | 140  |
| D2        | 140         | 140 | 140 | 420   | 140  |
| D3        | 140         | 140 | 140 | 420   | 140  |
| D4        | 140         | 140 | 140 | 420   | 140  |
| V3 D1     | 145         | 145 | 145 | 435   | 145  |



|       |     |     |     |     |     |
|-------|-----|-----|-----|-----|-----|
| D2    | 145 | 145 | 145 | 435 | 145 |
| D3    | 145 | 145 | 145 | 435 | 145 |
| D4    | 145 | 145 | 145 | 435 | 145 |
| V4 D1 | 122 | 122 | 122 | 366 | 122 |
| D2    | 122 | 122 | 122 | 366 | 122 |
| D3    | 122 | 122 | 122 | 366 | 122 |
| D4    | 122 | 122 | 122 | 366 | 122 |
| V5 D1 | 125 | 125 | 125 | 375 | 125 |
| D2    | 125 | 125 | 125 | 375 | 125 |
| D3    | 125 | 125 | 125 | 375 | 125 |
| D4    | 125 | 125 | 125 | 375 | 125 |
| V6 D1 | 120 | 120 | 120 | 360 | 120 |
| D2    | 120 | 120 | 120 | 360 | 120 |
| D3    | 120 | 120 | 120 | 360 | 120 |
| D4    | 120 | 120 | 120 | 360 | 120 |

## ANALYSIS OF VARIANCE

| SOURCE OF VARIANCE           | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN OF SQUARES | COMPUTED F      | TABULAR F |      |
|------------------------------|--------------------|----------------|-----------------|-----------------|-----------|------|
|                              |                    |                |                 |                 | 0.05      | 0.01 |
| Block                        | 2                  | 0.0000         | 0.0000          | Infinity        | <.0001    |      |
| Variety (A)                  | 5                  | 2472.0         | 1294.40         | Infinity*       | <.0001    |      |
| Duration of Weed Control (B) | 3                  | 0.0000         | 0.0000          | - <sup>ns</sup> | -         |      |
| AXB                          | 15                 | 0.0000         | 0.0000          | - <sup>ns</sup> | -         |      |
| Error                        | 46                 | 0.0000         | 0.0000          | -               |           |      |
| TOTAL                        | 71                 | 6472.0000      |                 |                 |           |      |

\* = Significant

Coefficient of Variation = 0

ns = Not significant

Appendix Table 5. Total number of pods

| TREATMENT | REPLICATION |     |     | TOTAL  | MEAN   |
|-----------|-------------|-----|-----|--------|--------|
|           | I           | II  | III |        |        |
| V1 D1     | 218         | 254 | 662 | 662.00 | 220.66 |
| D2        | 265         | 245 | 245 | 755.00 | 251.66 |
| D3        | 321         | 298 | 309 | 928.00 | 309.33 |
| D4        | 316         | 275 | 231 | 082.00 | 274.00 |
| V2 D1     | 091         | 069 | 062 | 222.00 | 058.00 |
| D2        | 059         | 042 | 073 | 174.00 | 074.00 |
| D3        | 147         | 144 | 143 | 434.00 | 201.66 |
| D4        | 196         | 216 | 193 | 605.00 | 144.66 |
| V3 D1     | 148         | 133 | 137 | 418.00 | 139.33 |



|       |     |     |     |         |        |
|-------|-----|-----|-----|---------|--------|
| D2    | 316 | 306 | 260 | 882.00  | 294.00 |
| D3    | 190 | 197 | 178 | 565.00  | 188.33 |
| D4    | 247 | 176 | 178 | 601.00  | 200.33 |
| V4 D1 | 220 | 261 | 297 | 778.00  | 259.33 |
| D2    | 367 | 357 | 448 | 1172.00 | 390.66 |
| D3    | 292 | 238 | 243 | 773.00  | 257.66 |
| D4    | 370 | 307 | 336 | 1013.00 | 337.66 |
| V5 D1 | 220 | 252 | 207 | 679.00  | 226.33 |
| D2    | 167 | 155 | 161 | 483.00  | 161.00 |
| D3    | 147 | 103 | 095 | 354.00  | 115.00 |
| D4    | 181 | 200 | 219 | 600.00  | 200.00 |
| V6 D1 | 116 | 092 | 152 | 360.00  | 120.00 |
| D2    | 078 | 073 | 094 | 245.00  | 081.66 |
| D3    | 187 | 212 | 209 | 608.00  | 202.66 |
| D4    | 145 | 024 | 108 | 377.00  | 125.66 |

## ANALYSIS OF VARIANCE

| SOURCE OF VARIANCE           | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN OF SQUARES | COMPUTED F | TABULAR F |      |
|------------------------------|--------------------|----------------|-----------------|------------|-----------|------|
|                              |                    |                |                 |            | 0.05      | 0.01 |
| Block                        | 2                  | 1845.03        | 922.51          | 1.45       | 0.2450    |      |
| Variety (A)                  | 5                  | 337417.90      | 6743.58         | 106.10*    | <.0001    |      |
| Duration of Weed Control (B) | 3                  | 26672.49       | 8890.83         | 13.98*     | <.0001    |      |
| AXB                          | 46                 | 145198.26      | 9679.88         | 15.22*     | <.0001    |      |
| Error                        | 15                 | 29257.64       | 636.03          |            |           |      |
| TOTAL                        | 71                 | 540391.32      |                 |            |           |      |

\*= Significant

Appendix Table 6. Average number of filled pods per plant

| TREATMENT | REPLICATION |        |        | TOTAL   | MEAN   |
|-----------|-------------|--------|--------|---------|--------|
|           | I           | II     | III    |         |        |
| V1 D1     | 180.00      | 221.33 | 180.00 | 0581.33 | 193.77 |
| D2        | 215.00      | 205.00 | 221.66 | 0641.66 | 213.88 |
| D3        | 315.33      | 312.33 | 293.03 | 0896.29 | 298.76 |
| D4        | 276.00      | 259.66 | 221.00 | 0750.66 | 252.22 |
| V2 D1     | 043.00      | 036.66 | 066.66 | 0140.32 | 046.77 |
| D2        | 061.66      | 063.33 | 057.66 | 0182.65 | 060.88 |
| D3        | 142.66      | 133.33 | 138.00 | 0413.99 | 137.99 |
| D4        | 088.66      | 172.00 | 180.33 | 0540.99 | 180.33 |
| V3 D1     | 133.33      | 123.33 | 117.00 | 0376.66 | 124.55 |



|       |        |        |        |         |        |
|-------|--------|--------|--------|---------|--------|
| D2    | 260.00 | 270.00 | 235.00 | 0765.00 | 255.00 |
| D3    | 160.33 | 157.00 | 153.66 | 0470.99 | 156.99 |
| D4    | 231.66 | 166.66 | 170.00 | 0567.99 | 189.33 |
| V4 D1 | 212.66 | 240.00 | 280.33 | 0732.00 | 244.33 |
| D2    | 341.00 | 279.00 | 313.33 | 0951.33 | 317.11 |
| D3    | 275.00 | 208.33 | 227.00 | 0710.33 | 236.77 |
| D4    | 321.00 | 318.66 | 407.33 | 1046.99 | 348.00 |
| V5 D1 | 201.00 | 236.33 | 190.66 | 0627.99 | 209.88 |
| D2    | 159.00 | 130.33 | 137.00 | 0426.33 | 142.11 |
| D3    | 111.00 | 097.66 | 080.33 | 0288.99 | 096.33 |
| D4    | 158.66 | 172.33 | 198.33 | 0529.32 | 176.44 |
| V6 D1 | 098.33 | 079.66 | 081.00 | 0288.99 | 086.33 |
| D2    | 065.66 | 064.33 | 063.66 | 0193.65 | 064.55 |
| D3    | 179.33 | 195.00 | 189.00 | 0558.33 | 186.11 |
| D4    | 131.33 | 101.66 | 081.33 | 0314.32 | 104.77 |

## ANALYSIS OF VARIANCE

| SOURCE OF VARIANCE           | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN OF SQUARES | COMPUTED F | TABULAR F |      |
|------------------------------|--------------------|----------------|-----------------|------------|-----------|------|
|                              |                    |                |                 |            | 0.05      | 0.01 |
| Block                        | 2                  | 1056.28        | 528.14          | 1.12       | <.0001    |      |
| Variety (A)                  | 5                  | 308518.28      | 61703.66        | 131.23*    | 0.3340    |      |
| Duration of Weed Control (B) | 3                  | 25331.13       | 8443.71         | 17.96*     | <.0001    |      |
| AXB                          | 15                 | 131077.71      | 8738.51         | 18.59*     |           |      |
| Error                        | 46                 | 21628.75       | 470.00          |            |           |      |
| TOTAL                        | 71                 | 48712.17       |                 |            |           |      |

\* = Significant

Coefficient of Variation = 12.03

Appendix Table 7. Average number of unfilled pods

| TREATMENT | REPLICATION |    |     | TOTAL  | MEAN  |
|-----------|-------------|----|-----|--------|-------|
|           | I           | II | III |        |       |
| V1 D1     | 38          | 33 | 10  | 081.00 | 27.00 |
| D2        | 50          | 40 | 24  | 114.00 | 38.00 |
| D3        | 09          | 08 | 16  | 033.00 | 11.00 |
| D4        | 40          | 16 | 10  | 066.00 | 22.00 |
| V2 D1     | 16          | 06 | 13  | 035.00 | 11.66 |
| D2        | 30          | 06 | 05  | 041.00 | 13.16 |
| D3        | 05          | 11 | 05  | 021.00 | 07.00 |
| D4        | 08          | 44 | 13  | 065.00 | 21.66 |
| V3 D1     | 15          | 10 | 20  | 045.00 | 15.00 |



|       |    |    |    |        |       |
|-------|----|----|----|--------|-------|
| D2    | 56 | 36 | 25 | 117.00 | 39.00 |
| D3    | 30 | 40 | 25 | 095.00 | 31.00 |
| D4    | 16 | 10 | 08 | 034.00 | 11.00 |
| V4 D1 | 08 | 21 | 17 | 046.00 | 15.33 |
| D2    | 46 | 39 | 41 | 126.00 | 42.00 |
| D3    | 17 | 30 | 16 | 063.00 | 21.00 |
| D4    | 29 | 10 | 23 | 062.00 | 20.66 |
| V5 D1 | 19 | 16 | 17 | 052.00 | 17.33 |
| D2    | 08 | 25 | 24 | 057.00 | 19.00 |
| D3    | 36 | 06 | 15 | 057.00 | 19.00 |
| D4    | 23 | 28 | 21 | 072.00 | 24.00 |
| V6 D1 | 18 | 13 | 71 | 102.00 | 34.00 |
| D2    | 13 | 09 | 31 | 053.00 | 17.66 |
| D3    | 13 | 17 | 20 | 050.00 | 16.00 |
| D4    | 14 | 23 | 27 | 064.00 | 21.33 |

## ANALYSIS OF VARIANCE

| SOURCE OF VARIANCE           | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN OF SQUARES | COMPUTED F | TABULAR F |        |
|------------------------------|--------------------|----------------|-----------------|------------|-----------|--------|
|                              |                    |                |                 |            | 0.05      | 0.01   |
| Block                        | 2                  | 121.00         | 60.50           | 0.41       |           | 0.6631 |
| Variety (A)                  | 5                  | 1171.79        | 234.36          | 1.61*      |           | 0.1776 |
| Duration of Weed Control (B) | 3                  | 1095.38        | 365.13          | 2.50*      |           | 0.0711 |
| AXB                          | 15                 | 3944.28        | 262.96          | 1.80*      |           | 0.0640 |
| Error                        | 46                 | 6714.33        | 145.96          |            |           |        |
| TOTAL                        | 71                 | 13046.88       |                 |            |           |        |

\*= Significant

Appendix Table 8. Total yield per plant (g)

| TREATMENT | REPLICATION |        |       | TOTAL  | MEAN   |
|-----------|-------------|--------|-------|--------|--------|
|           | I           | II     | III   |        |        |
| V1 D1     | 073.50      | 093.93 | 62.09 | 210.33 | 070.11 |
| D2        | 037.90      | 044.07 | 44.06 | 127.06 | 042.32 |
| D3        | 067.00      | 123.90 | 68.23 | 200.33 | 066.72 |
| D4        | 086.66      | 012.02 | 96.93 | 307.49 | 102.49 |
| V2 D1     | 012.07      | 011.73 | 11.03 | 036.02 | 012.06 |
| D2        | 014.93      | 052.80 | 13.36 | 040.02 | 013.34 |
| D3        | 031.03      | 037.08 | 33.05 | 117.06 | 039.02 |
| D4        | 059.00      | 037.08 | 48.04 | 154.02 | 048.04 |
| V3 D1     | 037.56      | 038.53 | 36.06 | 112.69 | 037.56 |



|       |        |        |       |        |        |
|-------|--------|--------|-------|--------|--------|
| D2    | 070.76 | 059.93 | 66.05 | 197.22 | 065.74 |
| D3    | 105.01 | 101.13 | 99.11 | 305.34 | 099.11 |
| D4    | 078.33 | 071.78 | 65.23 | 215.34 | 071.78 |
| V4 D1 | 054.06 | 055.33 | 64.93 | 174.32 | 058.10 |
| D2    | 046.36 | 048.06 | 56.07 | 151.66 | 050.55 |
| D3    | 085.63 | 094.05 | 76.83 | 256.96 | 085.65 |
| D4    | 090.76 | 071.46 | 96.08 | 259.02 | 086.34 |
| V5 D1 | 077.46 | 048.04 | 68.04 | 194.26 | 064.75 |
| D2    | 077.00 | 062.08 | 52.02 | 192.00 | 064.00 |
| D3    | 089.33 | 095.06 | 90.01 | 275.03 | 091.67 |
| D4    | 073.09 | 071.13 | 67.04 | 212.46 | 070.82 |
| V6 D1 | 030.83 | 027.93 | 32.05 | 091.26 | 030.42 |
| D2    | 018.05 | 017.04 | 18.56 | 054.46 | 018.15 |
| D3    | 031.26 | 028.36 | 29.03 | 088.92 | 029.64 |
| D4    | 052.06 | 53.16  | 72.56 | 178.32 | 059.49 |

## ANALYSIS OF VARIANCE

| SOURCE OF VARIANCE           | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN OF SQUARES | COMPUTED F | TABULAR F |      |
|------------------------------|--------------------|----------------|-----------------|------------|-----------|------|
|                              |                    |                |                 |            | 0.05      | 0.01 |
| Block                        | 2                  | 26.49          | 13.10           | 0.19       | 0.8278    |      |
| Variety (A)                  | 5                  | 256148.42      | 5029.68         | 72.32*     | <.0001    |      |
| Duration of Weed Control (B) | 3                  | 8341.62        | 2780.54         | 39.98*     | <.0001    |      |
| AXB                          | 15                 | 14076.53       | 938.44          | 13.49*     | <.0001    |      |
| Error                        | 46                 | 3199.06        | 69.54           |            |           |      |
| TOTAL                        | 71                 | 50792.03       |                 |            |           |      |

\* = Significant

Coefficient of Variation = 14.48

Appendix Table 9. Total yield per 1x3m plot (g)

| TREATMENT | REPLICATION |        |        | TOTAL   | MEAN   |
|-----------|-------------|--------|--------|---------|--------|
|           | I           | II     | III    |         |        |
| V1 D1     | 465.0       | 547.03 | 521.06 | 1614.07 | 538.03 |
| D2        | 387.4       | 397.07 | 355.06 | 1140.07 | 380.23 |
| D3        | 578.3       | 676.08 | 534.01 | 1789.02 | 596.04 |
| D4        | 621.0       | 714.07 | 599.03 | 1935.00 | 645.00 |
| V2 D1     | 108.8       | 123.02 | 107.08 | 0331.08 | 110.06 |
| D2        | 122.6       | 106.02 | 106.02 | 0335.00 | 111.66 |
| D3        | 157.7       | 241.41 | 159.09 | 0559.00 | 186.33 |
| D4        | 238.5       | 063.09 | 201.02 | 0603.06 | 201.01 |
| V3 D1     | 176.5       | 183.09 | 183.02 | 0543.06 | 181.02 |



|       |       |        |        |         |        |
|-------|-------|--------|--------|---------|--------|
| D2    | 366.4 | 337.03 | 359.05 | 1099.02 | 366.04 |
| D3    | 421.8 | 402.00 | 411.85 | 1235.65 | 411.88 |
| D4    | 354.9 | 330.85 | 298.09 | 0984.65 | 328.21 |
| V4 D1 | 362.7 | 366.05 | 442.04 | 1170.06 | 390.02 |
| D2    | 502.4 | 423.01 | 550.01 | 1475.06 | 491.86 |
| D3    | 618.4 | 599.04 | 520.07 | 1738.05 | 579.02 |
| D4    | 761.5 | 655.08 | 711.08 | 2129.01 | 709.07 |
| V5 D1 | 335.1 | 250.04 | 290.03 | 0875.08 | 291.93 |
| D2    | 441.5 | 398.04 | 347.02 | 1187.01 | 395.07 |
| D3    | 491.7 | 481.09 | 522.04 | 1558.00 | 519.33 |
| D4    | 553.7 | 423.09 | 495.05 | 1420.01 | 473.36 |
| V6 D1 | 145.0 | 141.09 | 160.02 | 0447.01 | 149.03 |
| D2    | 148.5 | 152.03 | 140.02 | 0441.00 | 147.00 |
| D3    | 303.8 | 226.01 | 233.02 | 0763.01 | 254.36 |
| D4    | 206.1 | 194.01 | 271.04 | 0671.06 | 223.86 |

## ANALYSIS OF VARIANCE

| SOURCE OF VARIANCE           | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN OF SQUARES | COMPUTED F | TABULAR F |      |
|------------------------------|--------------------|----------------|-----------------|------------|-----------|------|
|                              |                    |                |                 |            | 0.05      | 0.01 |
| Block                        | 2                  | 4161.51        | 2031.75         | 1.36       | 0.027     |      |
| Variety (A)                  | 5                  | 169919.62      | 339918.62       | 221.78*    | <.0001    |      |
| Duration of Weed Control (B) | 3                  | 323782.01      | 107027.33       | 70.42*     | <.0001    |      |
| AXB                          | 15                 | 186649.18      | 12443.28        | 8.12*      | <.0001    |      |
| Error                        | 46                 | 70504.41       | 1532.70         |            |           |      |
| TOTAL                        | 71                 | 2284697.2      |                 |            |           |      |

\* = Significant

Coefficient of Variation = 10.82

Appendix Table 10. Computed yield per hectare (kg/ha)

| TREATMENT | REPLICATION |        |        | TOTAL  | MEAN    |
|-----------|-------------|--------|--------|--------|---------|
|           | I           | II     | III    |        |         |
| V1 D1     | 1819.09     | 1824.3 | 1738.6 | 5382.8 | 1794.02 |
| D2        | 1291.03     | 1325.6 | 1185.3 | 3802.2 | 1267.04 |
| D3        | 1927.06     | 2255.9 | 1780.3 | 5963.8 | 1987.09 |
| D4        | 2069.09     | 2382.3 | 1997.6 | 6449.8 | 2149.09 |
| V2 D1     | 0335.09     | 0410.6 | 0359.3 | 1105.8 | 0368.00 |
| D2        | 0408.06     | 0353.9 | 0353.9 | 1116.4 | 3072.13 |
| D3        | 0525.06     | 0804.6 | 0532.9 | 1863.1 | 0621.03 |
| D4        | 0749.09     | 0546.3 | 0670.6 | 2011.8 | 0670.06 |
| V3 D1     | 0588.03     | 0612.9 | 0610.6 | 1811.8 | 0603.09 |





|       |         |        |        |        |         |
|-------|---------|--------|--------|--------|---------|
| D2    | 1221.31 | 1124.3 | 1318.8 | 3663.9 | 1221.03 |
| D3    | 0405.09 | 1339.9 | 1372.8 | 4118.6 | 1372.08 |
| D4    | 1182.09 | 1102.8 | 0966.3 | 3282.0 | 1394.00 |
| V4 D1 | 1205.06 | 1221.6 | 1474.6 | 3901.8 | 1300.06 |
| D2    | 1674.06 | 1410.3 | 1833.3 | 4918.5 | 1639.05 |
| D3    | 2061.03 | 1997.9 | 1735.6 | 5794.8 | 1931.06 |
| D4    | 2538.03 | 1854.9 | 2372.6 | 7096.8 | 2365.06 |
| V5 D1 | 1116.09 | 0834.6 | 0967.6 | 2919.1 | 0973.03 |
| D2    | 1469.09 | 1327.9 | 1157.3 | 3955.1 | 1318.04 |
| D3    | 1845.06 | 1606.3 | 1741.3 | 5193.2 | 1731.01 |
| D4    | 0483.03 | 1442.9 | 1651.6 | 4733.4 | 1557.08 |
| V6 D1 | 0494.09 | 0472.9 | 0533.9 | 1490.1 | 0496.07 |
| D2    | 0494.09 | 0507.6 | 0467.3 | 1469.8 | 0489.09 |
| D3    | 1021.06 | 0753.6 | 0777.3 | 2543.5 | 0847.08 |
| D4    | 0686.09 | 0646.9 | 0904.6 | 2238.9 | 0764.01 |

## ANALYSIS OF VARIANCE

| SOURCE OF VARIANCE           | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN OF SQUARES | COMPUTED F | TABULAR F |      |
|------------------------------|--------------------|----------------|-----------------|------------|-----------|------|
|                              |                    |                |                 |            | 0.05      | 0.01 |
| Block                        | 2                  | 46278.8        | 23139.40        | 1.36       | 0.027     |      |
| Variety (A)                  | 5                  | 1883060.3      | 3776613.82      | 221.78*    | <.0001    |      |
| Duration of Weed Control (B) | 3                  | 359345.81      | 1199115.27      | 70.42*     | <.0001    |      |
| AXB                          | 15                 | 2073874.1      | 138258.27       | 8.12*      | <.0001    |      |
| Error                        | 46                 | 7838896.2      | 17028.00        |            |           |      |
| TOTAL                        | 71                 | 2538896.2      |                 |            |           |      |

\* = Significant

Coefficient of Variation = 10.82

Appendix Table 11. Weight of 100 seeds (g)

| TREATMENT | REPLICATION |       |       | TOTAL  | MEAN  |
|-----------|-------------|-------|-------|--------|-------|
|           | I           | II    | III   |        |       |
| V1 D1     | 20.02       | 22.01 | 21.00 | 063.03 | 21.01 |
| D2        | 22.07       | 21.03 | 19.02 | 063.02 | 21.06 |
| D3        | 24.05       | 23.06 | 26.05 | 077.06 | 25.86 |
| D4        | 22.01       | 22.06 | 22.06 | 067.03 | 22.43 |
| V2 D1     | 24.03       | 18.02 | 14.05 | 057.00 | 20.75 |
| D2        | 20.57       | 21.03 | 20.04 | 062.27 | 19.00 |
| D3        | 19.03       | 21.05 | 22.06 | 063.04 | 21.13 |
| D4        | 18.04       | 22.09 | 20.06 | 061.09 | 20.63 |
| V3 D1     | 24.05       | 24.02 | 25.08 | 074.05 | 24.83 |





|       |       |       |       |        |       |
|-------|-------|-------|-------|--------|-------|
| D2    | 22.08 | 23.07 | 24.07 | 064.03 | 21.43 |
| D3    | 19.08 | 20.04 | 20.01 | 060.03 | 20.01 |
| D4    | 23.05 | 21.04 | 19.04 | 064.35 | 21.45 |
| V4 D1 | 37.05 | 35.05 | 36.05 | 109.05 | 36.05 |
| D2    | 29.01 | 28.02 | 28.06 | 085.09 | 28.63 |
| D3    | 32.05 | 33.05 | 33.01 | 099.01 | 33.03 |
| D4    | 35.04 | 33.04 | 34.04 | 103.02 | 34.04 |
| V5 D1 | 30.07 | 37.09 | 34.03 | 102.09 | 34.03 |
| D2    | 35.06 | 42.03 | 38.09 | 116.08 | 38.93 |
| D3    | 32.04 | 30.05 | 31.45 | 094.35 | 31.45 |
| D4    | 32.05 | 30.07 | 31.06 | 094.08 | 31.06 |
| V6 D1 | 39.02 | 37.00 | 38.01 | 114.03 | 38.01 |
| D2    | 36.00 | 34.03 | 35.01 | 105.04 | 35.13 |
| D3    | 42.02 | 39.08 | 41.00 | 123.00 | 41.00 |
| D4    | 37.03 | 40.05 | 38.09 | 116.07 | 38.09 |

## ANALYSIS OF VARIANCE

| SOURCE OF VARIANCE           | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN OF SQUARES | COMPUTED F | TABULAR F |      |
|------------------------------|--------------------|----------------|-----------------|------------|-----------|------|
|                              |                    |                |                 |            | 0.05      | 0.01 |
| Block                        | 2                  | 3.26           | 1.63            | 0.49       | 0.061     |      |
| Variety (A)                  | 5                  | 3437.01        | 687.58          | 207.87*    | <.0001    |      |
| Duration of Weed Control (B) | 3                  | 8.58           | 2.86            | 0.86*      | 0.47      |      |
| AXB                          | 15                 | 341.37         | 22.76           | 6.88*      | <.0001    |      |
| Error                        | 46                 | 152.16         | 3.31            |            |           |      |
| TOTAL                        | 71                 | 3943.28        |                 |            |           |      |

\* = Significant

Coefficient of Variation = 6.39

