Field screening of Chickpea (Cicer arientinum) genotypes against insect pests in the rainforest Zone of Owerri Imo State, Nigeria

SA Dialoke[1]*, NO Kabuo[2], FO Ojiako[1], CT Tom[1], MO Ofor[1], OP Obilo[1], and SA Isong[1].

[1]Department of Crop Science and Technology, School of Agriculture and Agricultural Technology, Federal University of Technology, Owerri, Imo State, Nigeria

[2]Department of Food Science and Technology, Federal University of Technology, Owerri, Imo State, Nigeria

*Corresponding Author: **akuamka@yahoo.com**

Abstract

Field screening for insect pest resistance in chickpea cultivars was carried out at the Department of Crop Science and Technology, Teaching and Research farm, Federal University of Technology, Owerri in the year 2012. Fifteen different cultivars of chickpea were screened in the field to find the resistance potentials of the cultivars when exposed to the insect pests' population in the zone. The experiment was carried out using randomized complete block design in three replications. The results showed that the cultivar ICCV 15333 was highly susceptible to the prevailing pod borers' complex (*Helicoverpa armigera Hubner*) unlike ICCV 16903 that was resistant to the same. As for the pod yield (kg ha-1), ICCV 6811 was found to give the highest yield, in comparison to ICCV 4495 and ICCV 2814, which gave the minimum pod yield. Generally, the pod yield was significantly affected by the larvae infestation coupled with the high temperature and acidity in the study area which also contributed to the low yield. However, there were more chances that chickpea could perform well in this locality, if appropriate planting time/plant densities were taken into consideration. This information prompted the ongoing research trials on chickpea in the departmental research farms.

Keywords: Chickpea, cultivars, insect pests, rainforest, screening,

Introduction

Chickpea (*Cicer arietinum* L.) which originated in the Southeastern Turkey (Ladizinsky, 1975) belongs to the genus cicer, tribe cicereae, family fabaceae and sub-family papilionaceae. The name *cicer* is of the Latin origin, derived from the Greek word *Kikus* meaning force or strength whereas originally the word *'Kikar'* means round (van der Maesen, 1987). The word arietinum is also Latin, translated from the Greek 'Krios', another name for both ram and chickpea, an allusion to the shape of the seed which resembles the head of a ram (van der Maesen, 1987). Chickpea is grown over an area of 10 million hectares in the world and the major chickpea-producing countries of the world are: India 6597 kg ha-1 (68%), Turkey 850 kg ha-1 (11%), and Pakistan 1023 kg ha-1 (8%) (Food and Agriculture Organization [FAO] production tapes, 1992).

Chickpea is grown in the tropical and temperate regions. The Kabuli type is grown in the temperate region while the Desi type is grown in the semi and tropical regions (Muelbauer and Singh, 1987, Malhotra et al., 1987)

Chickpea is used for food and medicinal purposes as stated by Homer in the Iliad (1000-800 BC) in Roman and in the Indian and medieval European literature (van der Maesen , 1972). It is valued for its nutritive seeds with high protein content, 25.3-28.9%, after dehulling (Hulse ,1991). The chickpea seeds are eaten fresh as green vegetables while Dhal (split chickpea without its seed coat) can be dried, fried, roasted or boiled, and used to make thick soup, bread or ground into flour for making snacks, sweets, and condiments (Hulse,1991)

Among the food legumes, chickpea is the most hypocholesteremic agent used for controlling the

cholesterol level in rats (Geervani,1991), with the help of the active ingredients like malic and oxalic acids, contained in the leaves. Other medicinal applications includes use for bronchitis, catarrh, cholera, diarrhea, constipation, flatulence, snake bite (Geervani,1991).

Chickpea also known as gram, is one of the important pulse crops in Bangladesh. It is attacked by eleven species of insect pests (Rahman et al., 1982). Among these pests, the pod borer, *Helicoverpa armigera* Hubner is the most serious one found in many of the chickpea growing areas of the country (Begun et al., 1992). Thus, the major constraints to chickpea production in tropics and sub tropics of Asia includes (i) infestation by insect pests particularly, pod borers (*Helicopverpa armigera* Hubner) and *Maruca vitrata* Fab. (Smithson et al., 1985), (ii) Cutworms (*Agrotis* sp), (iii) lesser army worms (*Spodoptera energua*) and (iv) leaf miners. In Nigeria, no work has been carried out with respect to the prevailing insect pests, climatic requirements, and the soil of chickpea. As an important legume crop, there is a need to incorporate it into the Nigeria's farming systems. So, the primary objective of this study is to screen the chickpea genotypes for pest resistance in rainforest zone of Imo State, Nigeria. Information derived from the research findings will provide the basic knowledge needed to those scientists who might be interested in carrying out further research on chickpea in Nigeria.

Materials and Methods

The screening experiment was carried out at the Department of Crop Science and Technology, Teaching and Research Farms, Federal University of Technology, Owerri, Imo State, Nigeria which is located in the rain forest belt, longitude 7° 12′ E and latitude 5° 27′ N of equator. The experiment was conducted from the beginning of April, 2012 to July, 2012. The annual mean rainfall during land preparation in April was 55.3mm while the maximum temperature recorded was 39^{o}C. During planting in May, annual rainfall of 187.4mm with the maximum temperature of 40^{o}C was recorded (Table 1).

An area of land measuring 8 × 39m (312.00m2) was cleared manually using cutlass and mapped during the months of April 2012. The experiment was carried out using a Randomized Complete Block Design with three replications and each was divided into 15 plots of size 2m × 2m (4m2) per plot. There were 1 m pathways between replications and 0.5m between plots, respectively. Fifteen cultivars of chickpea obtained from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India comprising of ICCV (ICRISAT Chickpea variety) 4495, ICCV 4463, ICCV 2884, 12028, 3325, 16903, 15333, 14831, 13523, 16915, 9002, 6811, ICCV 14815, ICCV 14799, and ICCV 1878 were randomly allocated into the plots and a total of 45 treatment combinations were formed.

Three seeds were planted per stand at a depth of 5 cm and at a distance of 0.2 m within the rows and 0.5m between the rows. This arrangement was later thinned to 1 plant per stand to yield a plant population of 57,692 plant ha-1. Each row of 10 chickpea plants represented a cultivar.

The collected data included meteorological data, soil chemical properties, percentage emergence, insect count at vegetative and podding stage, days to flower bud initiation, number of pods per plant, and pods yield kg ha-1.

Insects were visually counted on six randomly selected plants starting from 7.00 am till 8.30 am and were later collected and preserved in a collecting jar containing 75 percent ethyl alcohol. The identification was done using the preserved insect samples taken from the Department of Crop Science and Technology, Federal University of Technology, Owerri, Imo State, Nigeria.

Data analysis. Data on insect count were first transformed using the square root transformation as per Emerson and Stoto (1983) and were later subjected to Analysis of variance (ANOVA) as stated by Steel and Torrie (1980). Differences between the treatment means were separated using the Fishers Least Significance Difference (LSD) at 5 percent level of probability.

Results

Results revealed that rainfall of 187 mm during the months of May supported the germination of the cultivars and high rainfall of 285mm was recorded during the flowering and fruiting period in June (Table 1). The results in table 2 present the physical and chemical properties of the soil at the study site. The textural class of the soil was sandy loam (82%) with high level of acidity (pH 4.88 in water) and the total content of nitrogen, magnesium, calcium and sodium in the soil was very low. Table 3 shows the significant percentage germination ($p<0.05$), with ICCV 2884 having the highest percentage germination (62.22%) followed by ICCV 6811 (61.11%). The cultivars ICCV 9002 (48.89%) and ICCV 16903 (47.78%) had the lowest percentage germination. The population of lepidopteran larva (*Helicoverpa. armigera* Hubner) observed in the field during the vegetative and podding periods was significant at $p<0.05$. At vegetative phase there were low levels of H. *armigera* on most of the cultivars. At podding phase there was a significant population of H. *armigera* on the cultivars ICCV 15333 and ICCV 16915. But more specifically, the cultivars

ICCV 9002, ICCV 14815, and ICCV 1878 had the highest population of H. *armigera*.

The number of days taken by the cultivars to form flower buds were not significant at p>0.05. The cultivar ICCV 6811 had the highest number of pods per plant and also recorded the highest pod yield (83.00 kg ha-1) followed by the cultivars, ICCV 1878 (78.35 kg ha-1) and ICCV 4463 (75.00 kg ha-1).

Discussions

High level of temperature and rainfall were the two critical factors that adversely affected the growth and performance of the cultivars in the field. Thompson et al., (1987) in their work on chickpea in India reported that, temperature was the key environmental factor in determining the chickpea growth, development, and adaptation. The soils in the rainforest zones, particularly Owerri, are characterized by heavy rainfall, causing leaching and low natural fertility. This probably was the reason behind nutrient depletion and high level of acidity observed in this study. Germination of seeds was probably delayed due to the temperature stress (39.0°C) at the time of plantation. Covell et al. (1986) reported that there is a decrease in the percentage of germination of seeds at a temperature above 33°C and faster germination occurred at a temperature range of 31.8°C–33°C. Again, as stated by Robertson et al., 1996, in a controlled environment, chickpea can germinate over a wider range (10oC to 45°C) of temperatures. The high level of acidity and sandy loam in the soil could have also limited the germination percentage of the chickpeas. Mahler et al. (1988) in their study recorded that, chickpea plants grew well in soils of pH 5.2 to 7.2. Also, Moolani and Chandra (1970) observed that the best soils for growing chickpea was deep silty loam or silty clay loam, which was devoid of soluble salts.

Although found at low levels during vegetative and podding phases, the larva of *Helicoverpa armigera* Hubner was the major pest observed in the study. Smithson et al., (1985) also reported pod borers, as the most important pest that feed on leaves and on the developing seed of chickpea. In Bangladesh, Begun et al., (1992) also reported that pod borer, particularly *Helicoverpa armigera* Hubner, was the most serious pest in many of the chickpea growing areas of the country. Other pod borers such as cutworms (*Agrotis ipsilon* Hufnagel), leaf miners (*Liriomyzea cicerina*), and army worms (*Spodoptera exigua*) were also observed on the leaves and pods, as minor pests. The poor fertility of the soil did not favor the vegetative growth which resulted in the scanty or sparse production of fresh chickpea leaves for the larva to feed on. Also, the unfavorable temperature, high rainfall, and soil acidity in the vegetative and reproductive phases did not support the performance of the cultivars which invariably influenced the level of pests found on them. The phytochemical properties of the leaves had conferred immunity against pests attacks for ICCV 6811, ICCV 1878, and ICCV 4463 cultivars resulting in higher pods per plant and pod yield kg ha-1. This immunity could probably be due to the increased composition of biochemical exudates comprising of malic and oxalic acids from the plant. This finding was in agreement with Duke (1987), who also reported that glandular secretion from chickpea leaves and stems consisted of malic and oxalic acids which gave sour taste and thus protected the plant from the pest attacks.

As reported by Kumar and Rheenen (2000), the days to flower bud initiation were much longer than what was obtainable in India. They recorded 35 and 55 days for extra short duration chickpea (ICCV2) and medium duration variety (JG62), respectively. This could be due to the temperature stress during the reproductive development which often have negative impacts on pollen viability and fertilization (Hall 2004), floral bud development (Prasad et al., 2002), and seed filling stage (Boote et al., 2005).

Low pod yield per plant could be due to the poor growth and reproduction of chickpea. This finding was in agreement with Duthion and Pigeaire (1991), who reported that physiologically, temperature stress during reproductive development may have affected flower abortion, both before and after the pod abortion stages, thereby resulting in a decreased number of pods per plant.

Pod yield of 75–83 kg ha-1 was generally low in comparison to 400–600 kg ha-1 as recorded by Muelbauer et al., (1988) in India. Temperature stress during the reproductive development particularly after the commencement of pod set could result in significant pod abortion and decreased seed filling (Leport et al., 2006). However, Kaira et al., 2008 observed that there was a minimum decrease of 53 kg ha-1 of chickpea yield for every 1°C rise in temperature. Also, the high temperature could result in crop yield loss (Campbell et al., 1992) resulting from the damage caused to the reproductive organs (Paulsen 1994, Hall 2004) and the shortened period of the reproductive organs (Entz and Fowler 1991, Angadi et al., 2000).

Conclusion and Recommendations

The growth and development of chickpeas cultivated in Imo state is very poor, mostly due to bad weather conditions emanating from the time of sowing. Pod borers were observed as the major pests while cutworms, leaf miners and armyworms were observed as the minor pests'

species. However, the cultivars ICCV 6811, 1878, and 4463 had an appreciable level of resistance against the damage caused by pod borers and consequently recorded a higher pod yield per plant and pod yield kg ha-1 as compared to the other cultivars screened along with them.

Chickpea is an important legume in India and from the present study, it has been found suitable for production in Nigeria. Therefore, it is highly recommended that efforts should be made by the scientists to carry out field trial on chickpea at varying sowing dates and population densities from different ecological zones in Nigeria. This scientific information is very vital as it will assist those farmers who may want to incorporate chickpea into their farming system.

Plate 1 a and b: ***Helicoverpa armigera*** *in different colors*

Plate a and b: Chickpea pods

Acknowledgement

I wish to thank the Principal Scientist and Head Gene Bank, Hari D. Upadhyaya from (ICRISAT), India who supplied me with the chickpea germplasms used for the screening work. I am grateful to the members of academic staff from the Department of Crop Science and Technology (School of Agriculture and Agricultural Technology), Federal University of Technology, who contributed immensely to the success of this work. To my field assistants and typists, I wish them God's guidance.

Table 1. Data from Owerri, Imo State Agricultural Development Programme, (ADP) Meterological station from March-July, 2012.

	March	April	May	June	July
Rainfall (mm)	91.5	55.3	187.4	285.4	199.0
No. of Rain days	5	2	11	15	9
Max.Temp.	40	39	40	38	39
Min. Temp. (°C)	17	17	18	16	17

Table 2. Physical and Chemical properties of the soil at the study site

Soil properties	Values
% sand	82.15
% silt	6.92
% clay	10.93
pH (H20)	4.88
pH (Kcl)	4.85
OC %	1.59
Available phosphorus (ppm)	28.6
Magnesium (Mol/kg)	2.61
Calcium (mol/kg)	1.53
Sodium (mol/kg)	0.054
Total Nitrogen %	0.15
Acidity (mol/kg)	1.64
ECEC	5.834
% B.C.	89.00

Table 3. Some morphological attributes and yield (kg/ha) of chickpea cultivars in rainforest zone, Owerri, Imo State, Nigeria.

Cultivars	% germination	Days to flower bud initiation	Larval count at vegetative phase	Larval count at podding phase	No. of pods per plant	pod yield kg ha^{-1}
ICCV 4495	50.00	75.00	0.00	0.67	2.67	66.67
ICCV 4463	50.00	77.33	0.33	1.00	5.00	75.00
ICCV 2884	62.22	82.67	0.00	1.00	2.67	58.33
ICCV 12028	56.67	78.67	0.00	0.67	4.00	60.83
ICCV 3325	58.89	83.67	0.00	1.00	4.00	67.50
ICCV 16903	47.78	80.00	0.00	0.00	4.00	66.67
ICCV 15333	60.00	77.00	1.00	3.00	4.00	60.00
ICCV 14831	50.00	82.67	0.67	0.67	3.33	66.67
ICCV 13523	55.56	83.66	0.67	0.33	4.33	68.33
ICCV 16915	58.89	82.67	0.00	2.00	4.00	61.67
ICCV 9002	48.89	77.33	1.00	1.67	3.00	60.00
ICCV 6811	61.11	83.00	0.00	1.33	7.00	83.00
ICCV 14815	50.00	85.33	0.67	1.67	3.33	61.67
ICCV 14799	50.00	73.33	0.00	1.00	3.67	63.33
ICCV 1878	55.56	82.67	0.33	1.67	6.33	78.33
LSD 0.05	7.91	N.S.	0.49	1.05	2.39	6.43

References

Begun N, Hussain M and **Chowdhury S.L.** 1992. Effect of sowing date and plant density to pod borer incidence and grain yield of chickpea in Bangladesh. Intl. Chickpea Newslet. 27:19-21

Boote K.J, Allen L.H, Prasa P.VV, Synder A.M and **Thomas J.M.G.** 2005. Elevated temperatures and carbondioxide impact on pollination, reproduction, growth and yield severally globally important crops.

Campbell C.A, Zentner R.P, McConkey B.G and **Selles F.** 1992. Effects of nitrogen and snow management on efficient of water use by spring wheat grown annually on zero tillage. Can. J., plant Sci. 72:271-279.

Cowell S, Eilis R.H, Roberts E.H and **Summerfield R.J.** 1986. The influence of temperature on seed germination rate in grain legumes. In a comparison of chickpea, lentil, soybean and cowpea at constant temperature. Journal of Experimental Botany 37: 705-715.

Duke J.A. 1987. Hand book of legumes of world economic importance. Planum press, New York p.52-57.

Duthion C and **Pigeaire A.** 1991. Seed length corresponding to the final stage in seed abortion of three legumes. Crop Sci. 31: 1579-1583.

Emerson J.D and **Stoto M.A.** 1983. Transforming data. In Hoaglin, DC Mosteller F and Tukey JW (Eds.) Understanding Robust and Exploratory Data analysis. New Yorks: John Wiley, 247-282.

FAO (Food and Agricultural Organization of the United Nations) 1992. Tapes about statistics of food crops Rome. Italy Food and Agriculture Organization.

Geervani P. 1991. Utilization of chickpea in India and scope for novel and alternative uses, P. 47-54 in uses of tropical legumes. Proceedings of consultants meeting 27-30 March, 1989 (ICRISAT centre Patancheru, Andhra Pradesh, India).

Hall A.E. 2004. Breeding for adaptation to drought and heat stress on cowpea. Eur. J. Agron. 21: 447-454.

Hulse S.H. 1991. Nature, composition and utilization of grain legumes, P. 11-27. In uses of tropical legumes: Proceedings of a consultant meeting 27-30 march, 1989. ICRISAT Centre Patancheru, AP 502-324, India.

Kalra N, Charkonburty D, Sharma A Rai HK, Jolly M, Chander S, Kumar PR and **Sehgal M.** 2008. Effect if temperature on yield of some water crops in Northwest India, Current science 94, 82-88.

Kumar J, and **Rheenen HA van** 2000. A major gene for time of flowering in chickpea. Journal of Heredity, 91 (1) pp.67-88 ISSN 1465-7333.

Ladizinsky G. 1975. A new Cicer from Turkey. Notes from the Royal Botanic Gardens, Edinburgh 34: 201-202.

Leport L, Turner NC, Davies SL and **Siddique KHM.** 2006. Variation in pod production and abortion among chickpea cultivars under terminal drought Eur. J. Agron.24: 236-246.

Maelbauer F.J and **Singh K.B.** 1987. Genetics of chickpea P. 99-125 in MC Saxena and KB Singh (eds.). The chickpea CAB International: Wallingford, Oxon, UK.

Mahler R.L,Saxena M.C and **Aeschllmann J.**1988. Soil fertility requirements of pea, lentil, chickpea and faba bean. Pages 279-289 in world crops (Summerfield RJ ed.), Dordrecht, Kluwer Academic Publishers, The Netherlands.

Malhotra R.S, Pundir R.P.S, and **Slinkard A.E.** 1987. Genetic resources of chickpea P. 61-81 in M.C Saxena and K.B Singh (eds.). The chickpea CAB International: Cambrian News Ltd, Aberystwyed UK.

Moolani M.K and **Chandra S.** 1970. Gram cultivation in Haryana. Bulletin of the Haryana Agricultural University, Hisar India, 15pp.

Muelbauer F.J, Redden R.J, Nassib A.M, Robertson L.D and **Smithson J.B.** 1988. Population improvement in pulse crop. An assessment of methods and techniques, P. 943-966. In Summerfield R.J (ed.) World crops, cool season food legumes, Kluwer Academic publications Dordrecht, The Netherlands.

Paulsen G.M 1994. High temperature response of crop plant . In KJ Boote etal. (ed.). Physiology and determination of crop yield.

Prasad P.V.V, Boote KJ, Allen LG and **Thomas JMG.** 2002. Effect elevated temperatures and carbon dioxide on seed set and yield of kidney bean (*Phaseolus vulgaris* L.) Glob change Boi. 8: 710-721.

Rahman M.M, Mannan M.A and **Islam M.A.** 1982. Pest survey of major summer and winter pulses in Bangladesh. In: Proceedings of the National workshop on pulses. August 18-19. 1981. Edited by A.K. Kaul. Published by Director, BangladeshAgricultural Research Institute, Joydebpur, Dhaka, pp.265-273.

Robertson L.D, Singh K.B, Erksine W. and **Ali M,** and Moneim E.L. 1996. Useful genetic deversityin gerplasm

collectionof food and forage legumes from West Asia and North Africa. Germplasm Resource and crop evolution 43: 447-460.

Smithson J.B, Thompson J.A, and **Summerfield R.J.** 1985. Chickpea (*Cicer arietinum* L.) P.312-390 in RJ Summerfield and EH Roberts cadel. Grain legumes crops, Collins, Indian, UK.

Steel R.G.D and **Torrie JH.** 1980. Principles and procedures of statistics. 2nd Ed. McGraw-Hill Book Co. J. New York.

Thompson B.D, Siddique K.H.M and **Wilson J.M.** 1987. Grain legume species in low rainfall Mediterranean type environment 1. Phenology and seed yield Field Crops Research 54: 173-187.

van der Maesen L.J.G. 1972. A monograph of the genus with special reference to chickpea (*Cicer arietinum* L.) its ecology, and cultivation, Mededingen and Landbour whoges school (Communication Agricultural University) Wageningen, 72-110.

van der Maesen L.J.G. 1987. Origin, history and taxonomy of chickpea Pages 11-34 in The Chickpea (M.C Saxena and K.B Singh (eds). Wallingford Oxon CAB International.