http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 14 (7): 461-465, 2011
ISSN 1028-8880 / DOI: 10.3923/pjbs.2011.461.465

An investigation on Different Harvesting Methods on Young Pods of KKU # 922 Maize (*Zea mays* L.) Cultivar for Baby Corn Production

S. Kasikranan
Department of Plant Sciences, Faculty of Agriculture and Technology,
Nakhon Phanom University, Nakhon Phanom 48000, Thailand

Abstract: This study aimed to search for the best indicator to be used for the harvest of maize pods for baby corn production. A Randomized Complete Block Design (RCBD) with four replications was used. The treatments are: T_1 (Control) Taking sample when silks of female flower had extended from tip of pod up to 3 cm long T_2, silks had extended 1 cm long T_3, silks had extended 2 cm long T_4, blooming of female flower for 2 days T_5, blooming of female flowers for 4 days T_6, blooming of female flower for 6 days T_7, one third blooming of male flower T_8, two third blooming of male flower and T_9, full bloom of male flower. Five baby corn Characteristics were used i.e., (1) fresh weight of whole ears, (2) fresh weight of ears without husk, (3) commercial standard ears, (4) off standard ears and (5) disordered kernel-rows of ears. A range of scores from 1 to 9 was applied to judge quality and yield in each item of the five baby corn characteristics. A score of 1 = the best whilst further increases in scores indicated the decline in quality of baby corn. The results showed that an indicator for use in harvesting pods of maize for baby corn production was found with T_6, i.e. the best time for the harvest of pods is when the female flowers had bloomed for 6 days after the appearance of silks.

Key words: Baby corn, commercial baby corn, harvesting indicator, metric tonnes, maize

INTRODUCTION

Many types of maize (*Zea mays* L.) cultivars have been cultivated in many countries around the world particularly those located in the tropical and subtropical zones where climatic conditions favour the growth and yield of the crop for kernel yields, apart from the whole plant which is normally used as animal fodder especially for cattle. Maize (*Zea mays* L.) belongs to the genus Zea of the Maydeae tribe or Tripsaceae of the family Gramineae or Poaceae. There are eight genera in the Maydeae, five Oriental and three American. The origin of *Zea mays* L. is unknown since no ancestor has ever been recorded. Nevertheless, Barghoorn *et al.* (1954) reported the identification of maize pollen in a drill core taken at 70 m under Mexico City from strata established as being 80,000 years old the evidence revealed that the ancestor of maize was a wild relative and maize did not result from the hybridization of other related species. In addition there have been some archaeological evidences supporting the findings such as Galinat (1971) and Duncan (1975). Tollenaar and Dwyer (1999) reported that it is generally agreed that maize was first domesticated about 7,000 to 10,000 years ago in Southern Mexico. After domestication, the crop spread rapidly through North and South America reaching Northeast US and later Southern Canada prior to European colonization. The crop spread quickly throughout Europe and then to other parts of the world after the discovery of the Americas. Nowadays the crop has its important role in national economy in many countries around the globe particularly the countries in the tropics.

As a source of protein and carbohydrate maize of different cultivars has been used for human dietary food and animal rations. One important type of maize cultivars is sweet corn. It is normally used for fresh and canned food and some surplus amounts are normally exported overseas. The sweet corn canned food exporters include the USA, France, Japan, Taiwan, and Thailand. Another product derived from maize for domestic and overseas consumption is baby corn the young pods of maize plants where many countries including Thailand exported baby corn in the forms of fresh and canned food products. Thailand has been exporting fresh and canned products of maize overseas since , 1968 i.e., 43 years ago. In , 1993 Thailand dominated world trade in both fresh and canned products with an export figure up to 36,600 metric tonnes and later new producers shared the world market. They include the USA and Europe, including Sri Lanka Taiwan, China Zimbabwe, Aambia, Indonesia, South Africa, Nicaragua, Costa Rica, Guatemala and Honduras (Anonymous, 1995).

From, 2001 to, 2002 Thailand exported baby corn canned products up to 61,461 metric tonnes mainly to the USA Japan, the Netherlands, Germany and some smaller portions to other countries such as Malaysia. Furthermore, at the same time Thailand also exported fresh baby corn up to metric tonnes to the United Kingdom Japan and Malaysia. In addition, an amount of approximately 4,000 metric tonnes of fresh baby corn was used for domestic consumption (Ektassanawan *et al*., 2002). From the overall figures one may find the importance of baby corn in many respects e.g., the high demand for food supply of baby corn for domestic and overseas consumption a considerable amount of income being earned by growers and the need to supply adequate amount of baby corn products for domestic and overseas demands. At the early seventieth, the Thai growers used maize cultivars that purposely bred for animal feed in place of baby corn cultivars but later the plant breeders have established a number of cultivars for baby corn production such as SW 2, KU #1, SRC 6, Baby Corn # 1, G5414, KKU 922, SSW and CMB. These eight cultivars were used in a trial (July-October, 1998) carried out at Khon Kaen University Thailand. The results of the experiments revealed that KKU 922 ranked the first in baby corn industrial characteristics and harvesting age for baby corn production (Kasikranan *et al*., 2001). It was also found that each maize cultivar had its different desirable characteristics that ready for the harvest of baby corn production. Therefore KKU 922 cultivar was chosen for further investigation. The objectives of this experimental work consisted of (1) the search for physical appearance of male flowers that indicates the most appropriate harvesting period of the pods for baby corn production (2) suitable length of male flowers and its age to be used, as indicator for the harvest of pods and (3) the most appropriate length of extended silks from female pods for use as indicator in harvesting the pods for high quality baby corn. Therefore, it is of tangible value to carry out further experiments with the use of KKU 922 maize cultivar in order to provide adequate information on suitable harvesting period for baby corn production so that better quality and yield of the crop (KKU 922 cultivar) may be achieved.

MATERIALS AND METHODS

This maize (*Zea mays* L.) experiment was carried out at the Department of Agronomy Faculty of Agriculture and Technology Nakhon Phanom University Thailand during October , 2009 to March , 2010 to search for the most appropriate method for use in harvesting young pods of maize for baby corn industrial utilization. The maize of KKU 922 cultivar obtained from the Faculty of Agriculture Khon Kaen University was chosen due to its outstanding baby corn characteristics. The Roi-Et soil series (Oxic Paleustults) with a mean value of soil pH of 5.75 (1:2.5 soil water by volume) and soil organic matter content of 0.10% was used. The experimental design used was a Randomized Complete Block Design (RCBD) with four replications. The treatments used consisted of T_1 (Control) Taking sample when silks of female flower had extended from tip of pod up to 3 cm long T_2, silks had extended 1 cm long T_3, silks had extended 2 cm long T_4 blooming of female flower for 2 days T_5, blooming of female flower for 4 days T_6, blooming of female flower for 6 days T_7, one third blooming of male flower T_8, two third blooming of male flower and T_9, full bloom of male flower. The land area was ploughed twice followed by harrowing once. The experimental field was divided into 36 equal plots and each plot has a dimension of 3×5 m in width and length, respectively. A path of 1 m in width was used in between the plots. 2-3 Kernels of maize of KKU 922 cultivar were sown by hand directly in to the soil to the depth of approximately 3-5 cm with the distances between rows and within rows of 60×25 cm, respectively. One week after emergence seedlings were thinned out leaving only one seedling $hill^{-1}$ followed by weeding with the use of mechanical mean. At the same time urea chemical fertilizer (46-0-0, N-P-K) at a rate of 187.50 kg ha^{-1} was banded along the rows of maize seedlings. At 14 days after emergence, weeding of the same method was carried out again and at the same time a complete chemical fertilizer 15-15-15 (N-P-K) at a rate of 312.50 kg ha^{-1} was applied along the rows of maize plants followed by the ridging up of soil to support roots system for a better stand of the maize plants. Commencing at 34 days after emergence, samples of maize ears were initially harvested and the maize ears were determined using standard baby corn characteristics. The harvest of ears samples were strictly carried out as stated in the treatments used hence the harvests for ear samples were carried out up to day 34 after emergence. Observations on the appearance of silks were carried out daily and it was found that both male and female flowers were initiated at days 29 and 34 after emergence, respectively. The appearance of silks of the pods was found at day 30 after emergence. The harvests of pods were carried out up to day 38 after emergence. The harvest of maize pods for baby corn commercial standard was conformed to baby corn characteristics i.e. an individual baby corn should be straight with 4-11 cm long 1-1.5 cm in width each exhibited no kernel rows disordered with a slightly yellowish appearance (Anonymous, 2003).

The following parameters were used in determining commercial quality and yield of maize ears (baby corn). They include (1) fresh weight of whole ears. (2), fresh weight of ears without husk, (3) commercial standard ears, (4) off standard ears and (5) disordered kernel-rows of ears. In order to rank the effect due to treatments on baby corn physical quality and yield a range of scores from 1 to 9 was applied based on the five baby corn characteristics. A score of 1 = the best and further increases in scores of any replication in each treatment indicated the decline in physical quality of baby corn in other words the higher the scores the worst the quality of baby corn products. The obtained data were statistically calculated but excluded those being rated into scores. The statistical calculations were carried out with the use of a computer programme.

RESULTS

Fresh weight of maize pods with husk and pods without husk: The results showed that fresh weights of maize pods with husk were highest with T_6 followed by T_1, T_9 T_5, T_8, T_2, T_4 and T_7 with values of 27,418.75; 26,668.75 23,143.75 20,831.25, 20.500.00; 19,581.25; 18,000.00 16,750.00 and 16,168.75 kg ha^{-1}, respectively Table 1. The differences were large and statistically significant. For fresh weights of maize pods without husk, the results indicated that T_6 ranked the highest followed by T_1, T_9 T_3, T_5, T_8, T_7, T_2, and T_4 with values of 1,253; 1,187; 933 893; 853; 745; 733; 680 and 680, respectively. The differences were large and highly significant.

Standard baby corn, off standard baby corn and kernel rows disordered: The results revealed that amounts of standard baby corn were highest with T_1 followed by T_6 T_9, T_8, T_3, T_7, T_5, T_2, and T_4 with values of 559; 493; 453 437; 413; 413; 386; 360 and 306 kg ha^{-1}, respectively. There were no statistical differences found on standard baby corn among the nine treatments used Table 1. With off standard baby corn, the results showed that the highest value of off standard baby corn was found with T_6 followed by T_9, T_1, T_3, T_5, T_4, T_2, T_7, and T_8 with values of 760; 586; 578; 480; 466; 373; 320; 320 and 309 kg ha^{-1}, respectively. The differences were large and statistically significant. For the results on kernel rows disordered it showed that value of kernel rows disordered was highest with T_7 followed by T_2, T_5, T_9, T_1, T_8, T_3, T_6 and T_4 with values of 294; 293; 228; 227; 226; 195; 161 160 and 146 kg ha^{-1}, respectively. There were no statistical differences found on kernel rows disordered among the treated maiz plants.

Competitive scores on baby corn characteristics: Based on fresh weights upon industrial baby corn standard of the nine treatments with the use of five baby corn characteristics the results showed that scores on pods with husk were highest with T_6 and lowest with T_7 with scores of 1 and 9, respectively Table 2. Pods without husk were highest with T_6 and lowest with T_2 with scores of 1 and 9, respectively. Fresh baby corn was highest with T_1 (control) and lowest with T_4 with scores of 1 and 9, respectively. Off standard baby corn was highest with T_8 and lowest with T_6, respectively whilst kernel rows disordered ranked the first with T_4 and lowest with T_2 with scores of 1 and 7, respectively. When summed up the scores, it was found that the highest score was with T_2 and lowest with T_6, thus the best ranking positions (the best treatment) of the scores were found with T_6 followed (Kasikranan *et al*., 2001). When planting distances

Table 1: Mean values of fresh weights of pods with and without husk, standard baby corn, off standard baby corn and kernel-rows disordered of the nine treatments of KKU 922 maize cultivar, grown at the Experimental Farm College of Agriculture and Technology Nakhon Phanom University Thailand

Treatments	Fresh pods weights with husk (kg ha^{-1})	Fresh weights without husk (kg ha^{-1})	Standards pods baby corn (kg ha^{-1})	Off standard baby corn (kg ha^{-1})	Kernel-rows disordered (kg ha^{-1})
T_1 (control)	26,668.75a	1,187a	559	578ab	226
T_2	18,000.00bc	680b	360	320b	293
T_3	20,500.00abc	893ab	413	480ab	161
T_4	16,750.00bc	680b	306	373b	146
T_5	20,831.25abc	853ab	386	466ab	228
T_6	27,418.75a	1,253a	493	760a	160
T_7	16,168.75c	733b	413	320b	294
T_8	19,581.25bc	745b	437	309b	195
T_9	23,143.75ab	933ab	453	586ab	227
F-test	*	**	NS	*	NS
LSD	1447	400	-	294	-
SE±	379.33	101.17	105.37	100.95	83.51

Letter(s) indicated least significant differences at probability (p) * = 0.05 ** = 0.01, NS = non significant. T_1 = (Control) silks of female flowers had extended 3 cm long T_2 = Silks had extended 1 cm long T_3 = Silks had extended 2 cm long T_4 = Female flowers blooming for 2 days T_5 = female flowers blooming for 4 days T_6 = female flowers blooming for 6 days T_7 = One third in blooming of male flowers T_8 = Two third in blooming of male flowers and T_9 = Full bloom of male flowers

Table 2: An evaluation on the estimated scores based on fresh weights of five baby corn characteristics i.e. (1) pods with husk (2) pods without husk (3) standard baby corn (4) off standard baby corn (5) kernel-rows disordered total scores and ranking positions

Treatments	Pods with husk	Pods without husk	Standard baby corn	Off standard baby corn	Kernel-rows disordered	Total scores	Ranking positions
T_1 (control)	2	2	1	7	5	17	2
T_2	7	9	8	3	7	34	9
T_3	5	4	6	6	3	24	5
T_4	8	8	9	4	1	30	8
T_5	4	5	7	5	5	26	6
T_6	1	1	2	9	2	15	1
T_7	9	6	5	2	6	28	7
T_8	5	7	4	1	4	21	3
T_9	3	3	3	8	5	22	4

T_1 = (Control) silks of female flowers had extended 3 cm long T_2 = silks had extended 1 cm long T_3 = silks had extended 2 cm long T_4 = female flowers blooming for 2 days T_5 = female flowers blooming for 4 days T_6 = female flowers blooming for 6 days T_7 = one third in blooming of male flowers T_8 = two third in blooming of male flowers and T_9 = Full bloom of male flowers.

treated maize plants. by T_1 (control) T_8, T_9, T_3, T_5, T_7, T_4 and the worst was with T_2 with scores of 15, 17, 21, 22, 24, 26, 28, 30, and 34, respectively.

DISCUSSION

When considering initial mean values of both soil pH and organic matter% of Roi-Et soil series (Oxic Paleustults) being used for the growth of maize plants it was found that a mean value of soil pH of 5.75 could only reach a moderate level for the release of most soil nutrients whilst the initial mean value of soil organic matter of 0.10% could be considered as a low mean value for a poor soil type in the tropics. Thus an increase in organic matter up to at least 0.80-1.00% is relatively needed for this soil type hence more crop residues and organic manure should be added to the soil in order to improve soil conditions for growth of the maize plants or for any other agronomic plants. Furthermore, liming is needed for this soil type as to increase mean value of soil pH into a range from 6 to 6.5 (1:2.5 soil water by volume). This is to facilitate a better release of soil nutrients around the roots zone (Mengel and Kirkby, 1987; Miller and Donahue, 1990; Suksri, 1998a, b, 1999).

With the previous results derived from different trials carried out at the Department of Agronomy Khon Kaen University (Kasikranan *et al.*, 2001) it revealed that KKU 922 maize cultivar possessed its outstanding features in terms of baby corn rating score better than any other baby corn cultivars such as KU #1, SW2, SRC6, Baby Corn#1, G5414, CMB and SSW. Therefore KKU 922 was chosen for this work, one outstanding advantage derived from this cultivar is the rapid growth of pods when it took only 28 days after emergence to reach its harvesting date for baby corn production whilst other cultivars had reached its most appropriate harvesting dates for baby corn production much longer, which was up to 48 days after emergence for the CMB cultivar between rows and within rows were adjusted to attain leaf area index values (LAI) of the maize plants at a range from 6-7 (Kasikranan, 2003) at the harvesting date for baby corn production (with a mean value of 28 days after emergence) Baby corn 922 gave the highest baby corn production with its highest significant differences (1,423 kg ha^{-1} for the whole fresh baby corn and 638 kg ha^{-1} for commercial standard baby corn. These results derived from the growth of maize plants on Yasothon soil series (Oxic Paleustults).

For this current work, the maize plants were grown on Roi- Et soil series of the same great soil group (Oxic Paleustults). The results of the nine treatments used revealed that all treated plants with respect to an item on fresh pods weights with husk gave no significant differences over the control treatment (T_1) although there was a slightly greater fresh weight of the whole pods of T_6 (female flower blooming for 6 days) than the control treatment (T_1). The results suggested that an extension of silks at 3 cm long is still an acceptable indicator for the harvest of baby corn production. A similar trend was also found with the results derived from an item on fresh pods weights without husk but was not found with the items on standard baby corn and kernel-rows disordered where all of the treated plants gave no significant differences. Whilst the poorest results derived from the item on off standard baby corn which was found with T_6 followed by T_1, T_9, T_3, T_5, T_4, T_2, T_7 and T_8. Therefore it is not clear to judge more precisely what treatment should have given the best indicator for the harvest of pods for baby corn production. Thus further judgement was carried out where scores with a range from 1 to 9 were applied to each item of the five baby corn characteristics (the best quality was rated at a score of 1 and then the quality declines with an advance in scores up to 9). It was found that T_6 attained a score of 15 followed by T_1 (control) with a score of 17. The results indicated that the best indicator to be used for the harvest of baby corn is the extension of female silks for six days after the appearance of silks i.e. the counting must be recorded from the day that silks have exposed from the pods which could be observed by naked eyes. Therefore, an indicator on the extension of silks at 3 cm long (T_1, control) which has long been practiced by growers for the harvest of pods for baby corn production could possibly be of secondary importance. The result on ranking position on industrial baby corn characteristics is similar to the result reported by Kasikranan *et al.*(2001) where the nine cultivars of baby corn were used i.e. KU#1, SW2, SRC6, Baby corn #1, G5414, KKU922, CMB, and SSW. The results on industrial baby corn yields were lower than that reported by Faungfupong and Ochapong (1994) but greater than that of Sahoo and Panda (1997). The lower baby corn commercial yields could possibly be attributable to the low density of plant population apart from the poor soil conditions. Thus it is necessary to adjust planting distances between rows and within rows to suit soil fertility level as to attain leaf area index value (LAI) of 8. This optimum value of LAI could indicate approximately 90% radiant energy from the sun among leaf canopies for photosynthetic activity of the maize plants (Suksri, 1992, 1999). It was suggested that to attain the utmost yield of any agronomic crops in Northeast Thailand one must firstly improve soil conditions where soil pH should be at a range from 6-6.5 (1:2.5 soil water by volume) organic matter should be at a range from 0.8-1% available phosphorus should be greater than 30 ppm exchangeable potassium should be no lesser than 80 ppm whilst nitrogen should be at 0.04% (Suksri, 1999).

ACKNOWLEDGMENTS

The author wishes to thank personnel of the Department of Agronomy College of Agriculture Nakhon Phanom University for their kind assistance whilst the experiment was carried out. Associate Professor Dr. Suwit Laohasiriwong the President of Nakhon Phanom University for his kind encouragement and unfailing supports.

REFERENCES

Anonymous, 1995. Baby Corn. 1st Edn., Ministry of Agriculture and Cooperatives, Bangkok, Thailand.

Anonymous, 2003. Baby corn cultivation: Harvesting and storage. Food Market Exchange. http://www.foodmarketexchange.com/datacenter/product/vegetables/babycorn/detail/dc_pi_ft_babycorn0403.htm.

Barghoorn, E.S., M.K. Wolfe and K.H. Clisby, 1954. Fossil maize from the valley of Mexico. Botanical Museum Leaflets, 16: 229-240.

Duncan, W.G., 1975. Maize. In: Crop Physiology: Some Case Histories, Evans, L.T. (Ed.). Cambridge University Press, Cambridge, London, pp: 23-50.

Ektassanawan, C., N. Junjorhor, C. Balla, T. Tonglarp and P. Saritniran, 2002. Research and development on baby corn cultivars of Kaset Sart University, angkok. http:/www.ku.ac.th/kaset60/ku60/corn3.html.

Faungfupong, S. and P. Ochapong, 1994. Appropriate technology of baby corn production for Tumbon Tunglooknok, Kamphaeng Saen district, Nakhon Pathom province: I. Variety and plant population. Kasetsart J., 28: 14-21.

Galinat, W.C., 1971. The origins of maize. Ann. Rev. Gent., 5: 447-478.

Kasikranan, S., H. Jones and A. Suksri, 2001. Growth yield, qualities and appropriate sizes of eight baby corn cultivars (*Zea mays* L.) for industrial uses grown on oxic paleustults soil, Northeast Thailand. Pak. J. Biol. Sci., 4: 32-36.

Kasikranan, S., 2003. The effects of nutrient supply on the production of commercial baby corn (*Zea mays* L.) in Thailand. Ph.D. Thesis, Department of Biosciences University of Hertfordshire, College Lane, Hatfield, Herts, UK.

Mengel, K. and E.A. Kirkby, 1987. Principles of Plant Nutrient. 4th Edn., International Potash Institute, Bern, Switzerland.

Miller, W.M. and R.L. Donahue, 1990. Soils: An Introduction to Soils and Plant Growth. 6th Edn., Prentice Hall, Englewood Cliffs, New Jersey, ISBN-10: 0138202265.

Sahoo, S.C. and M.M. Panda, 1997. Fertilizer requirement of baby corn (*Zea mays* L.) in wet and winter seasons. Indian J. Agric. Sci., 76: 397-398.

Suksri, A., 1992. Effects of cattle manure, green manure and chemical fertilizer 13-13-21 (NPK) on growth and kernel yield of maize (*Zea mays* L.) grown on yasothon soil. J. Agric., 8: 204-210.

Suksri, A., 1998a. Effects of dolomite on growth and seed yields of soybeans (*Glycine max* L.) grown on oxic paleustult soil in Northeast Thailand. Pak. J. Biol. Sci., 1: 215-218.

Suksri, A., 1998b. Rainy season soybean (*Glycine max* L.) as influenced by nitrogen and potassium fertilizers, grown on oxic paleustults soil in Northeast Thailand. Pak. J. Biol. Sci., 1: 399-401.

Suksri, A., 1999. Some Agronomic and Physiological Aspects in Growing Crops in Northeast Thailand. 1st Edn., Khon Kaen University Press, Khon Kaen, Thailand, pp: 212.

Tollenaar, M. and L.M. Dwyer, 1999. Physiology of Maize. In: Crop Yield, Physiology and Processes, Smith, D.L. and Hamel (Eds.). Springer-Verlag, New York, pp: 169-204.