EFFECTS OF DROUGHT STRESS AND POTASSIUM ON GROWTH AND YIELD OF SWEET CORN

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ABSTRACT

The demand for corn is increasing due to the increase in human and livestock populations of Malaysia. Drought stress and fertilizer management are problems of corn cultivation and production. In this study, the growth and yield performance of Thai Supersweet corn variety were compared at different levels of drought stress and potassium rates. A pot experiment was conducted in 2017 inside an insect proof net-house of Faculty of Sustainable Agriculture (FSA), Universiti Malaysia Sabah. The experimental design used was completely randomized design (CRD) and each combination of treatment consisted of four replicates. The drought stress treatments were soil moisture content (SMC) of 29.00% (control), 14.50% and 7.25% whereas the rates of potassium fertilizer were 30, 60 and 90 kg/ha. The data was analyzed using Two-way ANOVA and LSD was applied to compare means. No interaction effect ($p>0.05$) were observed in stem girth, leaf number, leaf length, leaf width, leaf area, cob length, cob diameter, cob girth and chlorophyll content. However, the plant height, first cob height from soil surface, fresh cob weight, grain number per cob, 100 grain weight and free proline content shown interaction effect ($p<0.05$) among the treatments. It was concluded that 7.25% SMC + 30 kg/ha K (T3K1) was sufficient for irrigation and fertilization for the corn plants as there was no significant difference observed when compared to the control treatment, 29.00% SMC + 60 kg/ha K (T1K2). Further research should be conducted to study the drought stress and potassium effects on other corn varieties and in open field trial.

KESAN KEMARAU DAN KALIUM PADA PERTUMBUHAN DAN HASIL JAGUNG MANIS

ABSTRAK

Permintaan terhadap jagung semakin meningkat disebabkan oleh peningkatan penduduk Malaysia dan jumlah ternakan di Malaysia. Kemarau dan pengurusan baja adalah masalah penanaman dan pengeluaran jagung. Satu kajian telah dijalankan di dalam rumah kalis serangga Fakulti Pertanian Lestari (FPL), Universiti Malaysia Sabah pada tahun 2017. Dalam kajian ini, prestasi pertumbuhan dan hasil jagung manis, Thai Supersweet telah dibandingkan pada tahap kemarau dan kadar kalium yang berbeza. Reka bentuk eksperimen yang digunakan adalah Reka Bentuk Rawak Lengkap (CRD) dengan empat replikasi. Rawatan kemarau yang diaplikasi adalah kandungan lembapan tanah 29.00% (kawalan), 14.50% and 7.25% whereas the rates of potassium fertilizer were 30, 60 and 90 kg/ha. Data telah dianalisis dengan menggunakan ANAVA dua hala dan LSD digunakan untuk membandingkan min. Tiada perbezaan yang signifikan ($p>0.05$) diperhatikan dalam ukuran lilit pokok, bilangan daun, panjang daun, lebar daun, luas permukaan daun, panjang tongkol pertama, ukuran tongkol, ukuran lilitan tongkol dan kandungan klorofil. Walau bagaimanapun, ketinggian tumbuhan, tinggi tongkol dari paras permukaan tanah, berat tongkol, bilangan butiran jagung per tongkol, berat 100 butiran jagung per tongkol dan kandungan proline menunjukkan signifikan ($p<0.05$) antara rawatan. Kesimpulannya, 7.25% SMC + 30 kg/ha K (T3K1) mencukupi untuk pengairan dan pembajaan untuk tanaman jagung kerana tidak terdapat perbezaan yang signifikan jika dibandingkan dengan rawatan kawalan, 29.00% SMC + 60 kg/ha K (T1K2). Kajian lanjutan haruslah dijalankan untuk mengkaji kesan kemarau dan kalium pada variety jagung yang lain dan di padang terbuka.

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LIST OF SYMBOLS, UNITS AND ABBREVIATIONS

ABA	Abscisic acid
ANOVA	Analysis of Variance
AOSA	Association of Official Seed Analysts
CIMMYT	International Maize and Wheat Improvement Center
Cl^-	Chloride ion
$cmol_c/kg$	Centimoles per kilogram
CRD	Completely Randomized Design
DAS	Days after sowing
DAT	Days after transplanting
FAO	Food and Agriculture Organization of the United Nations
FSA	Faculty of Sustainable Agriculture
FW	Fresh weight
GAIN	Global Agricultural Information Network
IDR	Import Dependency Ratio
ISTA	International Seed Testing Association
K^+	Potassium ion
LAI	Leaf area index
LSD	Least Significant Difference
M	Molar
MARDI	Malaysian Agricultural Research and Development Institute
mL	Millilitre
mm	Millimetre
MOA	Ministry of Agriculture and Agro-Based Industry Malaysia
MOP	Muriate of Potash
N	Nitrogen
Na^+	Sodium ion
NPK	Nitrogen, phosphorus and potassium
NSW	New South Wales
P	Phosphorus
P_2O_5	Phosphorus pentoxide
PEG	Polyethylene glycol
pH	Potential of hydrogen
ppm	Parts per million
RM	Ringgit Malaysia
Rubisco	Ribulose 1,5-bisphosphate carboxylase/oxygenase
RuBP	Ribulose bisphosphate
RWC	Relative Water Content
SAS	Statistical Analysis Software
Sdn. Bhd.	*Sendirian Berhad*
SSR	Self-sufficiency Ratio
SWI	Seed Program Specific Work Instruction
TSP	Triple Super Phosphate
UMS	Universiti Malaysia Sabah
USDA	United States Department of Agriculture
w/v	Weight per volume
WUE	Water Use Efficiency

LIST OF FORMULAE

CHAPTER 1

INTRODUCTION

1.1 Introduction

Maize (*Zea mays* L.), also known as corn, is the third most important food grain crops after rice and wheat throughout the world. Corn is one of the most versatile crops which can be grown in diverse environmental conditions. There are more than 1.2 billion people in the world subsist on corn as a staple food which is known as a cereal grain with good source of energy. It is a grain food crop which rich in dietary fibre, protein and calories, vitamins A, C and E (McCann, 2009).

Nowadays, it is the most crucial raw ingredient in the livestock feed including chicken, cattle, goat and fish, but Malaysia is currently importing up to four million tonnes of corn grain worth about RM 3.1 billion a year (Sinar Harian, 2016). Despite of being a good source of food and feed, corn can also be utilized as a major ingredient of industrial products. According to Datuk Seri Ahmad Shabery Cheek, the Minister of Agriculture and Agro-based Industry, The Malaysia's food import bill 2015 was reported at RM 45.39 billion, whereas the food export amounted to only RM 27 billion, leaving a deficit of over RM 18 billion (Sinar Harian, 2016).

Datuk Seri Ahmad also stated that the world will have around 7.7 billion people by 2020 and the figure will be approximately 9.3 billion by 2050, hence the demand for corn in the developing countries will double between now and 2050 (Sinar Harian, 2016). In order to meet the local demands, the farmers in Malaysia have been encouraged to cultivate corn extensively. Our food import bill can be cut down by cultivating corn in a large-scale. However, corn often threatened by severe abiotic stresses, of which the most common is drought stress.

According to the USDA (2017), the area harvested of corn in Malaysia was 10,000 ha in 2016. Although Malaysia is able to produce 58,000 metric tonnes of corn in 2016, but the total consumption are 3.90 million metric tonnes in 2016. The total import of corn in Malaysia is 3.80 million metric tonnes whereas the total export is only 10,000 metric tonnes, which only occupy for 0.26% out of the total consumption (USDA, 2017). Due to the insufficient of production for human consumption and animal feed within the country, Malaysia is one of the largest import markets of corn.

In 2014, the self-sufficiency ratio (SSR) of sweet corn is 93.5% and the import dependency ratio (IDR) is 12.3% (Department of Statistics, 2015). The SSR is the extent to indicate whether the production is sufficient to meet the domestic needs whereas the IDR indicates the country's dependence on imports of agricultural commodities to meet the domestic needs.

As a result of insufficient corn production, Malaysia government is urging on the establishment of large-scale plantations of corn in the country. Unfortunately, the farmers and smallholders in Malaysia who do not own the knowledge of appropriate fertilizer application during drought stress condition tend to import nearly 100% of corn for local usage from other countries, which indirectly arouse to the reduction of outcome of the corn produce (Sinar Harian, 2016).

Drought is one of the significant limiting abiotic factors for crop productivity and had become an increasingly severe problem in many regions all over the world, which generally inhibits plant growth through reduced water absorption and nutrient uptake. In different parts of the world, more frequent and prolonged drought events are anticipated due to climate changes and global warming, which reduced the growth and final yield in crop plants. Drought stress happened in the corn field will reduce the production and yield of corn crop (Aslam *et al.*, 2013). One of the objectives of corn breeders is to improve the drought tolerance of corn.

1.2 Justification

According to the reported data by USDA (2017), the corn production in Malaysia is facing a lot of challenges in attaining full sufficiency level and incapable to ensure the national food security. The great amount of corn import from other countries further showed the severity of the problem. Moreover, several challenges engaged in the insufficient of corn production such as the climate change, resources scarcity and increment of population growth. The increment in population of Malaysia and livestock population caused an insufficient supply of corn to the locals. In addition, the disclosure of high import bill of Malaysia in 2015, which was about RM 45 billion had brought the Malaysia government to come to realize the need for cultivation of corn extensively. This initiative will be able to fulfill the national production of corn and reduce the amount of import bill in the following years. Moreover, water is considered as a main limiting natural resource. Thus, research on crop management practices that enhance drought resistance and plant growth when water supply is limited has become increasingly essential.

As farmers tend to import a huge amount of corn currently, application of proper amount of potassium fertilizer can help to minimize the effect of drought stress and hence increase the yield of corn. By studying the effect of drought stress on corn, we are able to observe how the plants react to drought and the mechanism involved in resisting drought. If the corn plant manifests to produce satisfactory yield with application of optimum potassium fertilizer under drought stress on oxisol, it is economical for the farmers and smallholders to cultivate it locally. The finding of the optimum rate of potassium fertilizer through this study can assist the farmers and smallholders to achieve maximum yield of corn even under drought stress condition. In case the corn production within the country is sufficient for the animal feed and human consumption, the import bill of Malaysia can thereupon be reduced and the national food security can be improved. This will also serve as a hint to further improve of sweet corn notably in breeding high yielding and drought-tolerant sweet corn variety.

1.3 Objectives

The objectives of this study are:

1. To investigate the effects of drought stress levels and potassium rates on growth and yield of corn.

2. To determine the effects of potassium fertilizer rates on growth and yield of corn under drought stress.

1.4 Hypothesis

H_0: There is no significant difference between different drought stress levels and different potassium rates on the growth and yield of corn grown on oxisol.

H_A: There is significant difference between different drought stress levels and different potassium rates on the growth and yield of corn grown on oxisol.

CHAPTER 2

LITERATURE REVIEW

2.1 Corn

Corn (*Zea mays* L.), also known as maize, is a member of the grass family Poaceae. It is a cereal crop which was first grown by people in ancient Central America and introduced in Malaysia as sweet maize in the early 1970's (Dauda, 2015). The word "maize" was derived from Spanish form of the indigenous Taino word for the plant, maiz (Dauda, 2015). There are a total of five species and many subspecies in the genus which are all similar to the cultivated maize, with less developed cobs. The wild ones are sometimes called teosintes, and they are all native to Mesoamerica some 8,000 years ago (MOA, 2016).

It is now the third most important cereal crop in the world and is the staple food source for people in many countries. It is highly desirable as an animal feed due to its high energy and feed value of the kernel, leaf and stem. According to Nuss and Tanumihardjo (2010), corn contains about 72% starch, 10% protein, and 4% fat, which supply an energy density of 365 Kcal/100 g. Corn can be grown throughout the year in most of the Asian countries for various purposes including fodder and feed for animals, food grain, sweet corn, green cobs, baby corn and popcorn (Ranum *et al.*, 2014). The corn grain is used for both human and animal consumption. It is grown primarily for grain and secondarily for fodder and raw materials for industrial processes.

2.1.1 Taxonomy of Corn

Corn belongs to the tribe Andropogoneae of the grass family, Poaceae. The taxonomy classifications of corn in botanical field in order of kingdom, division, class, order, family, genus, tribe and species are Plantae, Magnoliophyta, Liliopsida, Poales, Poaceae, Zea, Maydae and Zea mays respectively.

2.1.2 Botany of Corn

Corn (*Zea mays* L.) is a grass that belongs to the large and important family, 'Poaceae'. It is a tall, thick-stemmed annual grass, usually with a single stem. It varies in height from one to four meters tall, with one or more tillers which producing large, narrow, opposite leaves, borne alternately along the length of a solid stem (Lukeba *et al.*, 2013). It is monoecious and diclinous, with male and female inflorescences born separately on the same plant, hence it is a cross-pollinated plant.

According to Tripathi *et al.* (2011), the root system of corn is divided into three types, which are seminal roots, adventitious roots and brace roots. The seminal roots are the roots which develop from radicle and usually persist for long period, whereas the adventitious roots are the fibrous roots developing from the lower nodes of stem below ground level which are the effective and active roots of the plant. The brace roots, also known as prop roots are produced by the lower two nodes of the corn plant. The roots usually grow very rapidly and almost equally outwards and downwards. Favourable soils may allow corn root growth up to 60 cm laterally and in depth (Tripathi *et al.*, 2011).

The stem is cylindrical, solid and generally attains a thickness of 3 to 4 cm (Szőke, 2002). It normally possesses eight to 21 internodes with a height of 2 to 3 m depending upon variety (Tabanao and Bernardo, 2005). The internodes are short and fairly thick at the base of the plant; become longer and thicker higher up the stem, and then taper again (Szőke, 2002). The ear bearing internode is longitudinally grooved to allow proper positioning of the ear head (cob). The upper leaves in corn are more responsible for light interception and are major contributors of photosynthate to grain.

The leaves of corn plant grow alternately on the opposite sides of the stem. The number of leaves varies from 12 to 18. Quick ripening varieties have few leaves whereas late ripening varieties have many leaves. The leaf length varies between 30 and 150 cm, and the leaf width can be up to 15 cm. The leaves typically consist of sheath, auricle, ligule and blade (Schichnes *et al.*, 1997). It is supported by a prominent mid-rib along its entire length. The leaf blade is long, narrow, undulating and tapers towards the tip and is glabrous to hairy. The leaf sheath is the longitudinal dimension into the basal portion of a leaf whereas the distal or tip portion is known as the blade. The auricles are narrow at the midrib and expand towards the margins of the leaf (Freeling and Lane, 1994).

Corn plant bears its flowers in spikelets like all the inflorescences of grasses. The spikelets are of two types, which are male and female (Nielsen, 2002; SWI, 2015). The apex of the stem ends in the tassel, an inflorescence of male flowers and the female inflorescences are borne at the apex of condensed, lateral branches known as shanks protruding from leaf axils (Abendroth *et al.*, 2011; SWI, 2015). The male (staminate) inflorescence is a loose panicle which produces pairs of free spikelets each enclosing a fertile and a sterile floret. The female (pistillate) inflorescence is a spike which produces pairs of spikelets on the surface of a highly condensed rachis (Abendroth *et al.*, 2011).

The female flower is tightly covered over by several layers of leaves which known as husk, and they do not show themselves easily until emergence of the pale yellow silks from the leaf whorl at the end of the ear (SWI, 2015). The silks are the elongated stigmas that look like tufts of hair initially and later turn into green or purple colour (Abendroth *et al.*, 2011). Each of the female spikelets encloses two fertile florets; one of those ovaries will mature into a corn kernel once sexually fertilized by wind-blown pollen (SWI, 2015).

The grains of corn are surrounded on the cob by the chaffy remains of the glumes and the lemmas and paleas of the two flowers. The grains are supported on very short and spongy pedicels. A corn cob usually contains between 300 and 1,000 seeds (Tripathi *et al.*, 2011). The seeds are either rounded or dented according to variety. The colour of the corn seed varies greatly with variety, ranging from white through yellow, red and purple to almost black. The individual corn grain is botanically a caryopsis, a dry fruit containing a single seed fused to the inner tissues of the fruit case. The three main parts of corn seeds are the pericarp, endosperm and embryo (Doll *et al.*, 2017). The outer layer of the endosperm is the aleurone layer; a layer of cells in which most of the stored protein of the seed is laid down, but the bulk of the endosperm consists of large cells packed with starch grains (Doll *et al.*, 2017). The embryo itself is rich in fats, minerals and proteins and contains considerable quantities of sugars. Figure 2.1 shows the morphology of a corn plant.

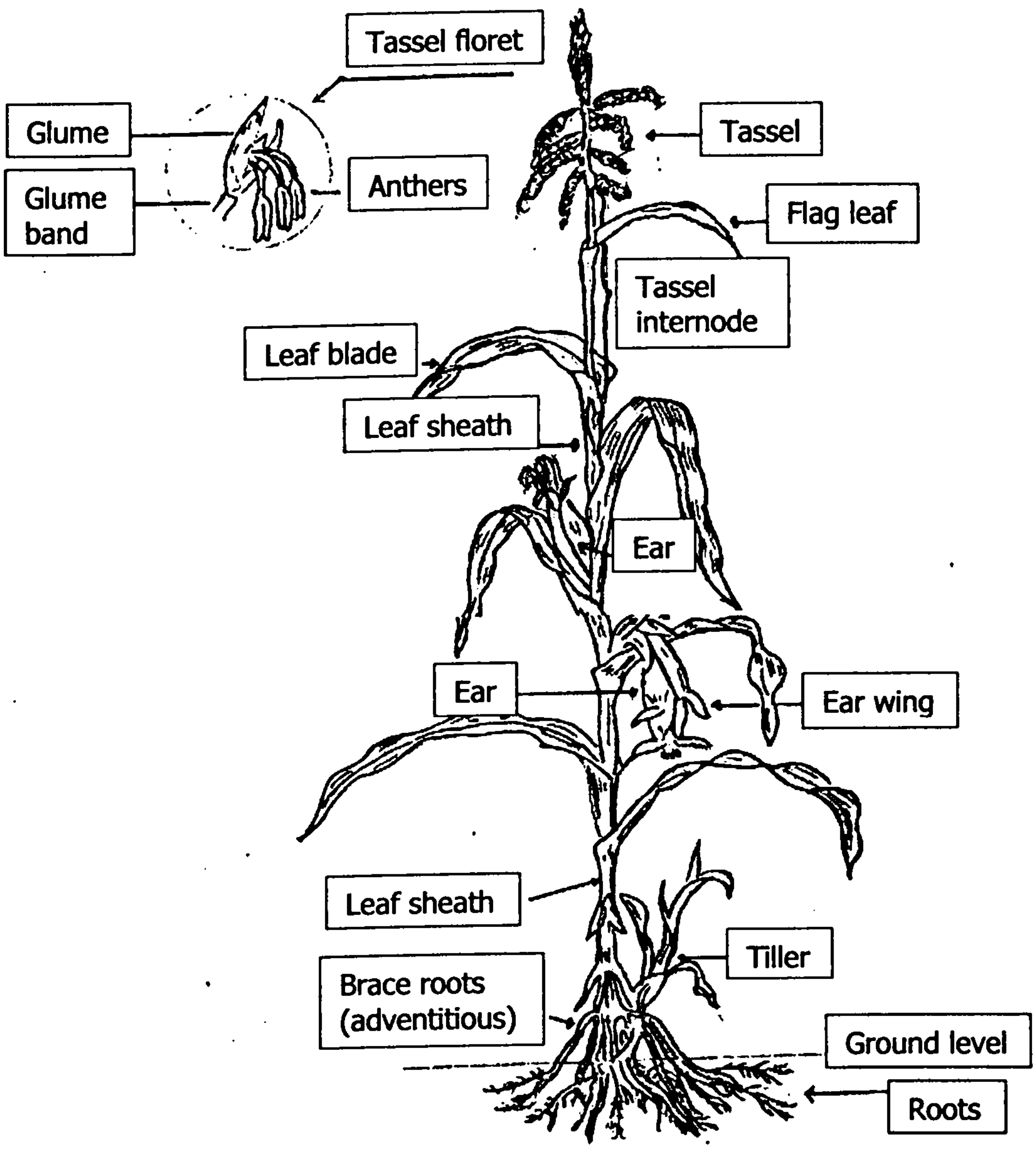

Figure 2.1 Morphology of corn plant
Source: Seed Program Specific Work Instruction (SWI), 2015

2.2 Growth and Development of Corn

Ordinarily, all varieties of corn follow the same general pattern of development. However, the specific time interval between stages and the total number of leaves developed may vary between different hybrids, time of planting, planting site, seasons and environmental stresses (Zaharah, 1992; Alom *et al.*, 2009). The development of a corn plant can be divided into two major phases, which are the vegetative stage and reproductive stage (Nielsen, 2002). The vegetative stage begins from seedling emergence to the formation of tassel whereas the reproductive stage commences at silking and pollination to the grain-filling and maturity (Zaharah, 1992).

2.2.1 Germination and Emergence

The favourable condition for corn seed germination and emergence is that the soil temperature for sowing should be above 21 °C and possess adequate and uniform moisture (Belfield and Brown, 2008; Milind and Isha, 2013). The corn seed sown in such conditions may undergo imbibition in a rapid mode and capable to emerge within two to three days. However, germination and emergence of corn seed will slow and uneven when the soil temperature is less than 18 °C (Milind and Isha, 2013). In this case, the radicle emergence may extend to a period of six to eight days. Additionally, radicle emergence will be slow if the depth of sowing of corn seed is deeper than 8 cm (Belfield and Brown, 2008).

The nutrient reserves in the endosperm of seed are used for feeding the emerging seedling from first week until the primary roots of the corn seedlings develop. Upon that, the corn seedlings can initiate the process to supply the plant with water and nutrients from the soil (Abendroth *et al.*, 2011). The first internode of the stem will grow rapidly until the seedling eventually emerges, which is usually four to five days after sowing. The prerequisites during this stage are that there must be optimum temperature and sufficient moisture in the soil which are deemed favourable for corn seed germination and emergence (Nielsen, 2015).

REFERENCES

Abd Allah, A. A. 2009. Genetic Studies on Leaf Rolling and Some Root Traits under Drought Conditions in Rice (*Oryza sativa* L.). *African Journal of Biotechnology* **8(22):** 6241–6248

Abd, A. H., Ismail, K. M. and El-Akabawy, M. A. 1997. Effect of Potassium on the Drought Resistance of Crops in Egyptian Conditions. Soils, Water and Environment, Research Institute, ARC, Giza, Egypt

Abendroth, L. J., Elmore, R. W., Boyer, M. J. and Marlay, S.K. 2011. Corn Growth and Development. PMR 1009. Iowa State University Extension, Ames, IA

Ache, P., Bauer, H., Kollist, H., Al-Rasheid, K. A., Lautner, S., Hartung, W. and Hedrich, R. 2010. Stomatal Action Directly Feeds Back on Leaf Turgor: New Insights into the Regulation of the Plant Water Status from non-invasive Pressure Probe Measurements. *The Plant Journal* **62(6):** 1072-1082

Ahmad, N., Khan, M. B., Farooq, S., Shahzad, M., Farooq, M. and Hussain, M. 2015. Potassium Nutrition Improves the Maize Productivity under Water Deficit Conditions. *Soil Environment* **34(1):** 15-26

Alom, M. S., Paul, N. K. and Quayyum, M. A. 2009. Performances of Different Hybrid Maize (*Zea mays* L.) Varieties under Intercropping Systems with Groundnut (*Arachis hypogaea* L.). *Bangladesh Journal of Agricultural Research* **34(4):** 585-595

Amanullah, Asif, I., Irfanullah and Zeeshan, H. 2016. Potassium Management for Improving Growth and Grain Yield of Maize (*Zea mays* L.) under Moisture Stress Condition. *Science Reports* 6: 34627

Anda, M., Shamshuddin, J., Fauziah, C. I. and Syed Omar, S. R. 2008. Mineralogy and Factors Controlling Charge Development of Three Oxisols Developed from Different Parent Materials. *Geoderma* **143(1):** 153-167

Anjum, S. A., Wang, L. C., Farooq, M., Khan, I. and Xue, L. 2011a. Methyl Jasmonate-induced Alteration in Lipid Peroxidation, Antioxidative Defense System and Yield in Soybean under Drought. *Journal of Agronomy and Crop Science* **197(4):** 296-301

Anjum, S. A., Xie, X. Y., Wang, L. C., Saleem, M. F., Man, C. and Lei, W. 2011b. Morphological, Physiological and Biochemical Responses of Plants to Drought Stress. *African Journal of Agricultural Research* **6(9):** 2026-2032

AOSA. 1993. Rules for Testing Seeds. *Journal of Seed Technology* **16(3):** 1-113

Aroca, R. 2012. Plant Responses to Drought Stress. From Morphological to Molecular Features. New York: Springer-Verlag Berlin Heidelberg

Asgharipour, M. R. and Heidari, M. 2011. Effect of Potassium Supply on Drought Resistance in Sorghum: Plant Growth and Macronutrition Content. *Pakistan Journal of Agricultural Sciences* **48(3):** 197–204

Ashraf, M. and Athar, H. U. R. 2005. Photosynthesis under Drought Stress. In Pessarakli, M. (Eds.). *Handbook of Photosynthesis*. New York: CRC Press

Ashraf, M., and Foolad, M. 2007. Roles of Glycine Betaine and Proline in Improving Plant Abiotic Stress Resistance. *Environmental and Experimental Botany* **59(2):** 206-216

Aslam, M., Zamir, M. S. I., Afzal, I., Yaseen, M., Mubeen, M. And Shoaib, A. 2013. Drought Stress, its Effect on Maize Production and Development of Drought Tolerance through Potassium Application. *Agronomical Research in Moldavia* **46(2):** 99-114

Auxtero, E. A. and Shamshuddin, J. 1991. Growth of Oil Palm (*Elaies guineensis*) Seedlings on Acid Sulfate Soils as Affected by Water Regime and Aluminum. *Plant and Soil* **137(2):** 243-257

Badu-Apraku, B., Fakorede, M. A. B., Menkir, A. and Sanogo, D. 2012. *Conduct and Management of Maize Field Trials.* Nigeria: International Institute of Tropical Agriculture. 30-31

Bãnziger, M., Edemeades, G. O., Beck, D. and Bellon, M. 2000. Breeding for Drought and Nitrogen Stress Tolerance in Maize: From Theory to Practice. Mexico: CIMMYT

Basu, S., Ramegowda, V., Kumar, A. and Pereira, A. 2016. Plant Adaptation to Drought Stress. *F1000 Research* **5**

Bates, L. S., Waldren, R. P. and Teare, I. D. 1973. Rapid Determination of Free Proline for Water Stress Studies. *Plant and Soil* **39(1)**: 205-207

Belfield, S. and Brown, C. 2008. Field Crop Manual: Maize-A Guide to Upland Production in Cambodia. New South Wales: NSW Department of Primary Industries

Berke, T. G. and Rocheford, T. R. 1995. Quantitative Trait Loci for Flowering, Plant and Ear Height, and Kernel Traits in Maize. *Crop Science* **35(6):** 1542-1549

Bismillah, K. M., Hussain, N. and Iqbal, M. 2001. Effects of Water Stress on Growth and Yield Component of Maize Variety YHS 202. *Journal of Research (Science)* **12:** 15-18

Blum, A. 2005. Drought Resistance, Water-use Efficiency, and Yield Potential - Are They Compatible, Dissonant, or Mutually Exclusive? *Crop and Pasture Science* **56(11):** 1159-1168

Bolanos, J. and Edmeades, G. O. 1996. The Importance of the Anthesis-Silking Interval in Breeding for Drought Tolerance in Tropical Maize. *Field Crops Research* **48(1):** 65–80

Bota, J., Medrano, H. and Flexas, J. 2004. Is Photosynthesis Limited by Decreased Rubisco Acivity and RuBP Content under Progressive Water Stress? *New Phytologist* **162(3):** 671–681

Bowman, W. D., Hubick, K. T. and Von Caemmerer, S. 1989. Short Term Changes in Leaf Carbon Isotope Discrimination in Salt and Water Stressed C_4 Grasses. *Plant Physiology* **90(1):** 162-166

Brewbaker, J. L. 2008. Sweet Corn. *Bulletin of College of Tropical Agriculture and Human Resources.* University of Hawaii

Bunnag, S. and Pongthai, P. 2013. Selection of Rice (*Oryza sativa* L.) Cultivars Tolerant to Drought Stress at the Vegetative Stage under Field Conditions. *American Journal of Plant Sciences* **4(9)**: 1701–1708

Cakir, R. 2004. Effect of Water Stress at Different Development Stages on Vegetative and Reproductive Growth of Corn. *Field Crops Research* **89(1):** 1–16

Cakmak, I. 2005. The Role of Potassium in Alleviating Detrimental Effects of Abiotic Stresses in Plants. *Journal of Plant Nutrition and Soil Science* **168(4):** 521–530

Cassel, D. K. and Nielsen, D. R. 1986. Field Capacity and Available Water Capacity. In Klute, A. (Ed.). *Methods of Soil Analysis Part 1 Physical and Mineralogical Methods Second Edition.* Wisconsin: American Society of Agronomy Incorporation

Chaves, M. M. 1991. Effects of Water Deficits on Carbon Assimilation. *Journal of Experimental Botany* **42(1):** 1–6

Chaves, M. M., Flexas, J. and Pinheiro, C. 2009. Photosynthesis under Drought and Salt Stress: Regulation Mechanisms from Whole Plant to Cell. *Annals of Botany* **103(4):** 551–560

Chaves, M. M., Maroco, J. P. and Pereira, J. S. 2003. Understanding Plant Responses to Drought-from Genes to the Whole Plant. *Functional Plant Biology* **30(3):** 239-264

Chen, J. Xu, W., Velten, J., Xin, Z. and Stout, J. 2012. Characterization of Maize Inbred Lines for Drought and Heat Tolerance. *Journal of Soil and Water Conservation* **67(5):** 354-364

Chutia, J. and Borah, S. P. 2012. Water Stress Effects on Leaf Growth and Chlorophyll Content but not the Grain Yield in Traditional Rice (*Oryza sativa* Linn.) Genotypes of Assam, India: II. Protein and Proline Status in Seedlings under PEG Induced Water Stress. *American Journal of Plant Sciences* **3(7)**: 971-980

Claassen, M. M. and Shaw, R. H. 1970. Water Deficit Effects on Corn. II. Grain Components. *Agronomy Journal* **62(5):** 652-655

Coors, J. G., Albrecht, K. A., and Bures, E. J. 1997. Ear-fill Effects on Yield and Quality of Silage Corn. *Crop Science* **37(1):** 243-247

Cornic, G. 2000. Drought Stress Inhibits Photosynthesis by Decreasing Stomatal Aperture-Not by Affecting ATP Synthesis. *Trends in Plant Science* **5(5):** 187–188

DaCosta, M. and Huang, B. 2006. Osmotic Adjustment Associated with Variation in Bentgrass Tolerance to Drought Stress. *Journal of the American Society for Horticultural Science* **131(3):** 338–344

Dagdelen, N., Yilmaz, E., Sezgin, F. and Gurbuz, T. 2006. Water-yield Relation and Water Use Efficiency of Cotton and Second Crop Corn in Western Turkey. *Agriculture Water Management* **82:** 63-85

Dai-Junying, C. J. 1996. Effect of Drought on Photosynthesis and Grain Yield of Corn Hybrids with Different Drought Tolerance. *Acta Agronomica Sinica* **22(6):** 757-762

Damayanthi, M. M. N., Mohotti, A. J. and Nissanka, S. P. 2011. Comparison of Tolerant Ability of Mature Field Grown Tea (*Camellia sinensis* L.) Cultivars Exposed to a Drought Stress in Passara Area. *Tropical Agricultural Research* **22(1):** 66-75

Dauda, A. O. 2015. Effect of Blanching and Oven Drying on the Sensory Quality of Stored Fresh Maize. *International Journal of Agriculture Innovations and Research* **3(4):** 1009-1013

Daynard, T. B. and Duncan, W. 1969. The Black Layer and Grain Maturity in Corn. *Crop Science* **9(4):** 473-476

Decov, I., Tsonev, T. and Yordanov, I. 2001. Effects of Water Stress and High Temperature Stress on the Structure and Activity of Photosynthetic Apparatus of *Zea mays* and *Helianthus annuus*. *Photosynthetica* **38(3):** 361-366

Demir, A. O., Goksoy, A. T., Buyukcangaz, H., Turan, Z. M. and Koksal, E. S. 2006. Deficit Irrigation of Sunflower (*Helianthus annuus* L.) in a Sub-humid Climate. *Irrigation Science* **24(4):** 279–289

Denmead, O. T. and Shaw, R. H. 1960. The Effects of Soil Moisture Stress at Different Stages of Growth on the Development and Yield of Corn. *Agronomy Journal* **52(5):** 272-274

Dent, D. H., Bagchi, R., Robinson, D., Majalap-Lee, N. and Burslem, D. F. 2006. Nutrient Fluxes via Litterfall and Leaf Litter Decomposition Vary Across a Gradient of Soil Nutrient Supply in a Lowland Tropical Rain Forest. *Plant and Soil* **288(1-2):** 197-215

Department of Statistics. 2015. *Supply and Utilization Accounts Selected Agricultural Commodities, Malaysia 2010-2014.* The Office of Chief Statistician Malaysia

DeWalt, S. J., Ickes, K., Nilus, R., Harms, K. E. and Burslem, D. F. R. P. 2006. Liana Habitat Associations and Community Structure in a Bornean Lowland Tropical Forest. *Journal of Plant Ecology* **186(2):** 203–216

Dey, S. C. 2010. *Fruit Growing in Pots.* India: Agrobios

Dezfuli, P. M., Sharif-Zadeh, F. and Janmohammadi, M. 2008. Influence of Priming Techniques on Seed Germination Behavior of Maize Inbred Lines (*Zea mays* L.). *Journal of Agricultural and Biological Science* **3(3):** 22-25

Dias, M. C. and Bruggemann, W. 2010. Limitations of Photosynthesis in *Phaseolus vulgaris* under Drought Stress: Gas Exchange, Chlorophyll Fluorescence and Calvin Cycle Enzymes. *Photosynthetica* **48(1):** 96-102

Doll, N. M., Depège-Fargeix, N., Rogowsky, P. M. and Widiez, T. 2017. Signaling in Early Maize Kernel Development. *Molecular Plant* **10(3):** 375-388

Doorenbos, J. and Kassam, A. H. 1979. Yield Response to Water. *Irrigation and Drainage Paper* **33:** 257-265

Efeoğlu, B., Ekmekçi, Y. and Çiçek, N. 2009. Physiological Responses of Three Maize Cultivars to Drought Stress and Recovery. *South African Journal of Botany* **75(1):** 34–42

Egilla, J. N., Davies, F. T. and Boutton, T. W. 2005. Drought Stress Influences Leaf Water Content, Photosynthesis, and Water-use Efficiency of *Hibiscus rosa-sinensis* at Three Potassium Concentrations. *Photosynthetica* **43(1):** 135–140

Egilla, J. N., Davies, F. T. and Drew, M. C. 2001. Effect of Potassium on Drought Resistance of *Hibiscus Rosa-Sinensis* Cv. Leprechaun: Plant Growth, Leaf Macro- and Micronutrient Content and Root Longevity. *Plant and Soil* **229(2):** 213-224

Ehab, A. 2016. Effect of Water Stress and Biological Fertilization on Maize Growth, Chemical Composition and Productivity in Calcareous Soil. *American Journal of Plant Physiology* **11:** 1-11

El Sabagh, A., Barutçular, C. and Saneoka, H. 2015. Assessment of Drought Tolerance Maize Hybrids at Grain Growth Stage in Mediterranean Area. *International Journal of Biological, Biomolecular, Agricultural, Food and Biotechnological Engineering* **9(9):** 1005-1008

Elmore, R. W. 2012. Stress, Anthesis-Silk Interval and Corn Yield Potential. In: *Proceedings of the Integrated Crop Management Conference.* 28 – 29 November 2012. Ames, Lowa

English, M. 2010. Deficit Irrigation I: Analytical Framework. *Journal of Irrigation, Drainage and Engineering* **116:** 399-410

Expansion Rate in the Recovery of Stressed White Clover Leaves with Increased Phosphorus Concentration. *New Phytologist* **146(2)**: 261-269

Ezzat, M. A., Noormohammadi, G., Ghodsi, M. and Kafi, M. 2010. Effect of Water Stress and Spraying of Potassium Iodide on Agronomic Traits and Grain Yield of Bread Wheat (*Tiriticum aistivum* L.) Genotypes. *Iran Journal of Field Crops Research* **8(2):** 177-186

Fahramand, M., Mahmoody, M., Keykha, A., Noori, M. and Rigi, K. 2014. Influence of Abiotic Stress on Proline, Photosynthetic Enzymes and Growth. *International Research Journal of Applied and Basic Sciences* **8(3)**: 257-265

Fanaei, H. R., Galavi, M., Kafi, M. and Ghanbari Bonjar, A. 2012. Amelioration of Water Stress by Potassium Fertilizer in Two Oilseed Species. *International Journal of Plant Production* **3(2):** 41-54

Farooq, M., Wahid, A., Kobayashi, N., Fujita, D. and Basra, S. M. A. 2009. Plant Drought Stress: Effects, Mechanisms and Management. *Agronomy for Sustainable Development* **29:** 185–212

Farquhar, G. D., Hubick, K. T., Codon, A. G. and Richards, R. A. 1989. Carbon Isotope Fractionation and Plant Water Use Efficiency. In Rundel, P. W., Ehleringer, J. R. and Nagy, K. A. (Ed.). *Stable Isotopes in Ecological Research.* New York: Springer-Verlag. 21-40

Farsiani, A. Ghobadi, M. E. and Jalali-Honarm, S. 2011. The Effect of Water Deficit and Sowing Date on Yield Components and Seed Sugar Contents of Sweet Corn (*Zea mays* L.). *African Journal of Agricultural Research* **6(26):** 5769-5774

Fathi, A. and Tari, D. B. 2016. Effect of Drought Stress and its Mechanism in Plants. *International Journal of Life Sciences* **10(1):** 1-6

Fedina, I. S., Georgieva, K. and Grigorova, I. 2002. Light-dark Changes in Proline Content of Barley Leaves under Salt Stress. *Institute of Plant Physiology* **45(1):** 59-63

Fitzpatrick, E. A. 1986. *An Introduction to Soil Science*. 2nd edition. Singapore: Longman Singapore Publishers Pte Ltd

Freeling, M. and Lane, B. 1994. The Maize Leaf. In Freeling, M. and Walbot, V. (Eds.). *The Maize Handbook*. New York: Springer-Verlag. 17-28

Frey, N. M. 1982. Dry Matter Accumulation in Kernels of Maize. *Crop Science* **21:** 118-122

Gao, J. F. 2000. *Experimental Techniques for Plant Physiology*. Xi'an, China: World Publishing Corporation

Ghannoum, O. 2009. C_4 Photosynthesis and Water Stress. *Annals of Botany (London)* **103(4):** 635-644

Ghassemi-Golezani, K. and Lotfi, R. 2012. Response of Soybean Cultivars to Water Stress at Reproductive Stages. *International Journal of Plant, Animal and Environmental Sciences* **17:** 198-202

Ghassemi-Golezani, K., Zafarani-Moattar, P., Raey, Y. and Mohammadi, M. 2010. Response of Pinto Bean Cultivars to Water Deficit at Reproductive Stages. *Journal of Food, Agriculture and Environment* **8(2):** 801-804

Gill, S. S. and Tuteja, N. 2010. Reactive Oxygen Species and Antioxidant Machinery in Abiotic Stress Tolerance in Crop Plants. *Plant Physiology and Biochemistry* **48(12):** 909-930

Goldman, M. 2006. *Imperial nature: The World Bank and Struggles for Social Justice in the Age of Globalization.* Yale University Press

Grant, R. F., Jackson, B. S., Kiniry, J. R. and Arkin, G. F. 1989. Water Deficit Timing Effects on Yield Components in Maize. *Agronomy Journal* **81(1):** 61–65

Gray, S. B. and Brady, S. M. 2016. Plant Developmental Responses to Climate Change. *Developmental Biology* **419(1):** 64-77

Gul, S., Khan, M. H., Khanday, B. A. and Nabi, S. 2015. Effect of Sowing Methods and NPK Levels on Growth and Yield of Rainfed Maize (*Zea mays* L.). Scientifica, University of Agricultural Sciences and Technology of Kashmir

Gyenes-Hegyi, Z., Pok, I., Kizmus, L., Zsubori, Z., Nagy, E. and Marton, L. C. 2002. Plant Height and Height of the Main Ear in Maize (*Zea mays* L.) at Different Locations and Different Plant Densities. *Acta Agronomica Hungarica* **50(1):** 75-84

Ha, P. T. T. 2014. Physiological Responses of Rice Seedlings under Drought Stress. *Journal of Science and Development* **12(5):** 635–640

Haeder, H. E., Mengel, K. and Forster, H. 1973. The Effect of Potassium on Translocation of Photosynthates and Yield Pattern of Potato Plants. *Journal of the Science of Food and Agriculture* **24(12):** 1479-1487

Hagos, B. G. 2016. Effect of Potassium Fertilizer on Crop Production. *Journal of Natural Sciences Research* **6(7):** 81-86

Hajibabaei, M. and Azizi, F. 2012. Effect of Phenologic and Leaf Morphologic Characteristics of New Maize Hybrids in Drought Stress. *International Research Journal of Applied and Basic Sciences* **3(9):** 1966-1973

Hajibabaei, M., Azizi, F. and Zargari, K. 2012. Effect of Drought Stress on Some Morphological, Physiological and Agronomic Traits in Various Foliage Corn Hybrids. *American-Eurasian Journal of Agricultural and Environmental Sciences* **12(7):** 890-896

Hamilton, D. W. A., Hills, A., Kohler, B. and Blatt, M. R. 2000. Ca^{2+} Channels at the Plasma Membrane of Stomatal Guard Cells are activated by Hyperpolarization and Abscisic Acid. *Proceedings of the National Academy of Sciences USA* **97(9):** 4967-497

Hanway, J. J. 1962. Corn Growth and Composition in Relation To Soil Fertility: II. Uptake of N, P, and K and Their Distribution in Different Plant Parts during the Growing

Hassan, M., Qayyum, A., Razzaq, A., Ahmad, M., Mahmood, I., Ullah Khan, S., Bibi, Y. and Jenks, M. 2013. Evaluation of Maize Cultivars for Drought Tolerance Based on Physiological Traits Associated with Cell Wall Plasticity. *Jokull Journal* **63(7):** 466-478

Hayat, S., Hayat, Q., Alyemeni, M. N., Wani, A. S., Pichtel, J. and Ahmad A. 2012. Role of Proline under Changing Environments: A Review. *Plant Signal and Behaviour* **7(11)**: 1456-1466

Heidaiy, Y. and Moaveni, P. 2009. Study of Drought stress on Accumulation and Proline among ABA in Different Genotypes Forage Corn. *Research Journal of Biological Sciences* **4(10):** 1121-1124

Herrero, M. P. and Johnson, R. R. 1981. Drought Stress and its Effects on Maize Reproductive Systems. *Crop Science* **21(1):** 105-110

Herzog, H. 1986. Source and Sink during the Reproductive Period of Wheat. Development and its Regulation with Special Reference to Cytokinins. Scientific Publishers: Berlin and Hambburg

Hsiao, T. C. 1973. Plant Responses to Water Stress. *Annual Review of Plant Physiology* **24(1):** 519-570

Hussain, M., Bashir, W., Farooq, S. and Rehim, A. 2013. Root Development, Allometry and Productivity of Maize Hybrids under Terminal Drought Sown by Varying Method. *International Journal of Agriculture and Biology* **15:** 1243-1250

ISTA. 1996. International Rules for Seed Testing Rules. *Seed Science and Technology.* **24:** 155-202

Jaleel, C. A., Manivannan, P., Wahid, A., Farooq, M., Al-Juburi, H. J., Somasundaram, R. and Panneerselvam, R. 2009. Drought Stress in Plants: A Review on Morphological Characteristics and Pigments Composition. *International Journal of Agriculture and Biology* **11(1):** 100-105

Jatoi, W. A., Baloch M. J., Kumbhar, M. B., Khan, N. U. and Kerio, M. I. 2011. Effect of Water Stress on Physiological and Yield Parameters at Anthesis Stages in Elite Spring Wheat Cultivars. *Sarhad Journal of Agriculture* **27(1):** 59-65

Jensen, H. E. and Mogensen, V. P. 1984. Yield and Nutrient Contents of Spring Wheat Subjected to Water Stress at Various Growth Stages. *Acta Agriculturae Scandinavica* **34(4):** 527–533

Jeremy, O. 2008. Potassium in Crop Nutrition. *Albion Plant Nutrition* **9(8):** 1-3

Jusop, S. and Ishak, C. F. 2010. Alleviating Acid Soil Infertility Constrains Using Basalt, Ground Magnesium Limestone and Gypsum in a Tropical Environment. *Malaysian Journal of Soil Science* **14:** 1-13

Kadioglu, A. and Terzi, R. 2007. A Dehydration Avoidance Mechanism: Leaf Rolling. *The Botanical Review* **73(4)**: 290–302

Kadioglu, A., Terzi, R., Saruhan, N. and Saglama, A. 2012. Current Advances in the Investigation of Leaf Rolling Caused by Biotic and Abiotic Stress Factors. *Plant Science* **182**: 42-48

Kaiser, W. M. 1987. Effect of Water Deficit on Photosynthetic Capacity. *Plant Physiologia Plantarum* **71(1):** 142-149

Kamara, A. Y., Menkir, A., Badu-Apraku, B. and Ibikunle, O. 2003. The Influence of Drought Stress on Growth, Yield and Yield Components of Selected Maize Genotypes. *The Journal of Agricultural Science* **141(1):** 43

Kant, S. and Kafkafi, U. 2002. Potassium and Abiotic Stresses in Plants. Pasricha, NS and SK Bansal: Plant Roots: The Hidden Half. New York: Marcel Dekker Incorporated 435-449

Karaba, A., Dixit, S., Greco, R., Aharoni, A., Kurniawan R. T., Nayelli, M. M., Arjun, K., Karaba, N. N., Makarla U. and Andy, P. 2007. Improvement of Water Use Efficiency in Rice by Expression of HARDY, an Arabidopsis Drought and Salt Tolerance Gene. *Proceedings of the National Academy of Sciences USA* **104(39):** 15270–15275

Katerji, N., Tardieu, F., Bethenod, O. and Quetin, P. 1994. Behavior of Maize Stem Diameter during Drying Cycles: Comparison of Two Methods for Detecting Water Stress. *Crop Science* **34(1):** 165-169

Kavar, T., Maras, M., Kidric, M., Sustar-Vozlic J. and Meglic V. 2007. Identification of Genes Involved in the Response of Leaves of *Phaseolus vulgaris* to Drought Stress. *Molecular Breeding* **21(2)**: 159–172

Keyvan, S. 2010. The Effects of Drought Stress on Yield, Relative Water Content, Proline, Soluble Carbohydrates and Chlorophyll of Bread Wheat Cultivars. *Journal of Animal and Plant Sciences* **8(3):** 1051-1060

Khan, M. B., Yousaf, F., Hussain, M., Haq, M. W., Lee, D. J. and Farooq, M. 2012. Influence of Planting Methods on Root Development, Crop Productivity and Water Use Efficiency in Maize Hybrids. *Chilean Journal of Agricultural Research* **72(4):** 556-563

Khan, Z. H., Khalil, S. K., Iqbal, A., Ullah, I., Ali, M., Shah, T., Wu, W. and Shah, F. 2017. Nitrogen Doses and Plant Density Affect Phenology and Yield of Sweet Corn. *Fresenius Environmental Bulletin* **26(6):** 3809-3815

Khoshvaghti, H., Mohammad Eskandari-Kordlar and Lotfi, R. 2014. Response of Maize Cultivars to Water Stress at Grain Filling Phase. *Azarian Journal of Agriculture* **1(1):** 39-42

Kishor, P. B. K., Sangama, S., Amrutha, R. N., Laxmi, P. S., Naidu, K. R. and Rao, K. S. 2005. Regulation of Proline Biosynthesis Degradation, Uptake and Transport in Higher Plants: Its Implications in Plant Growth and Abiotic Stress Tolerance. *Current Science* **88(3)**: 424-438

Klepper, B., Rickman, R. W. and Peterson, C. M. 1982. Quantitative Characterization of Vegetative Development in Small Cereal Grains. *Agronomy Journal* **74(5):** 789–792

Kohler, B. and Blatt, M. R. 2002. Protein Phosphorylation Activates the Guard Cell Ca^{2+} Channel and is a Prerequisite for Gating by Abscisic Acid. *Plant Journal* **32(2):** 185-194

Kramer, P. J. and Boyer, J. S. 1995. Water Relations of Plants and Soils. San Diego: Academic press

Krauss, A. and Johnston, A. E. 2002. Assessing Soil Potassium, Can We Do Better?. In: *9th International Congress of Soil Science on "Soil management under stress environment"*. Faisalabad, Pakistan. 18-20

Kumar, R. R., Karajol, K. and Naik, G. R. 2011. Effect of Polyethylene Glycol Induced Water Stress on Physiological and Biochemical Responses in Pigeon pea (*Cajanus cajan* L. Mill sp.). *Recent Research in Science and Technology* **3(1):** 148-152

Kuroda, M., Oaiawa, T. and Imagawa, H. 1990. Changes in Chloroplast Peroxidase Activities in Relation to Chlorophyll Loss in Barley Leaf Segments. *Physiologia Plantarum* **80(4):** 555-560

Kuscu, H. and Demir, A. O. 2012. Responses of Maize to Full and Limited Irrigation at Different Plant Growth Stages. *Journal of Agricultural Faculty of Uludag University* **26(2):** 15-27

Lauer, J. 2001. How Does Flooding Affect Corn Yield?. *Wisconsin Crop Manager* **8(14):** 96-97

Lauer, J. 2012. The Effects of Drought and Poor Corn Pollination on Corn. *Field Crops* **28:** 493-495

Lawlor, D. W. 2002. Limitation to Photosynthesis in Water Stressed Leaves: Stomata versus Metabolism and the Role of ATP. *Annals of Botany* **89(7):** 871-885

Lawlor, D. W. and Tezara, W. 2009. Causes of Decreased Photosynthetic Rate and Metabolic Capacity in Water-deficient Leaf Cells: A Critical Evaluation of Mechanisms and Integration of Processes. *Annals of Botany* **103:** 543-549

Leong, C. O. 2005. Asas dan Keperluan Tanaman Jagung Manis. In *Manual Teknologi Penanaman Jagung Manis MARDI.* Serdang: MARDI

Li, L. and Van Staden, J., 1998. Effects of Plant Growth Regulators on Drought Resistance of Two Maize Cultivars. *South African Journal of Botany* **64(2):** 116–120

Li, L., Staden, J. V. and Jäger, A. K. 1998. Effects of Plant Growth Regulators on the Antioxidant System in Callus of Two Maize Cultivars Subjected to Water Stress. *Plant Growth Regulation* **25(2):** 81-87

Li, R. H., Guo, P. G., Michael, B., Stefania, G. and Salvatore, C. 2006. Evaluation of Chlorophyll Content and Fluorescence Parameters as Indicators of Drought Tolerance in Barley. *Agricultural Sciences in China* **5(10):** 751-757

Lichtenthaler, H. K. 1987. Chlorophylls and Carotenoids, the Pigments of Photosynthetic Biomembranes. In Douce, R. and Packer, L. (Eds.). *Methods Enzymol.* New York: Academic Press Incorporation

Ligunjang, C. 2010. *Spatial Varibility of Soil pH, Exchangeable Potassium, Calcium and Magnesium of a Selected Area at University Malaysia Sabah Campus in Sandakan.* Bachelor of Science Dissertation. University Malaysia Sabah

Lindhauer, M. G. 1985. Influence of K Nutrition and Drought on Water Relations and Growth of Sunflower. *Journal of Plant Nutrition and Soil Science* **148(6):** 654-669

LiXin, Z., ShengXiu, L. and ZongSuo, L. 2009. Differential Plant Growth and Osmotic Effects of Two Maize (*Zea mays* L.) Cultivars to Exogenous Glycinebetaine Application under Drought Stress. *Plant Growth Regulator* **58(3):** 297–305

Lobell, D. B., Bänziger, M., Magorokosho, C. and Vivek, B. 2011. Nonlinear Heat Effects on African Maize as Evidenced by Historical Yield Trials. *Nature Climate Change* **1(1):** 42–45

Lorens, G. F., Bennett, J. M. and Loggale, L. B. 1987. Differences in Drought Resistance between Two Corn Hybrids. II. Component Analysis and Growth Rates. *Agronomy Journal* **79(5):** 808-813

Losch, R., Jensen, C. R. and Anderson, M. N. 1992. Diurnal Courses and Factorial Dependencies of Leaf Conductance and Transpiration of Differently Potassium Fertilized and Watered Field Grown Barley Plants. *Plant Soil* **140(2):** 205–224

Lukeba, J. C. L., Vumilia, R. K., Nkongolo, K. C., Mwabila, M. L. and Tsumbu, M. 2013. Growth and Leaf Area Index Simulation in Maize (*Zea mays* L.) under Small-scale Farm Conditions in a Sub-saharan African Region. *American Journal of Plant Sciences* **4(3):** 575-583

Lum, M. S., Hanafi, M. M., Rafii, Y. M. and Akmar, A. S. N. 2014. Effect of Drought Stress on Growth, Proline and Antioxidant Enzyme Activities of Upland Rice. *Journal of Animal and Plant Sciences* **24(5):** 1487-1493

Maathuis, F. J. M. and Sanders, D. 1996. Mechanisms of Potassium Absorption by Higher Plant Roots. *Physiology Plantarum* **96(1):** 158–168

Mafakheri, A., Siosemardeh, A., Bahramnejad, B., Struik, P. C. and Sohrabi, Y. 2010. Effect of Drought Stress on Yield, Proline and Chlorophyll Contents in Three Chickpea Cultivars. *Australian Journal of Crop Science* **4(8):** 580-585

Maisura, C. M., Lubis, I., Junaedinand, A. and Ehara, H. 2014. Some Physiological Character Responses of Rice under Drought Conditions in a Paddy System. *Journal of the International Society for Southeast Asian Agricultural Sciences* **20(1)**: 104–114

Majid, M. A., Islam, M. S., Sabagh, A. E. L., Hasan, M. K., Barutcular, C., Ratnasekera, D. and Islam, M. S. 2017. Evaluation of Growth and Yield Traits in Corn under Irrigation Regimes in Sub-Tropical Climate. *Journal of Experimental Biology* **5(2):** 143-150

Malaysian Society of Soil Science. 1977. Characteristics of Some Soils in Sabah and Sarawak. In: Conference on Classification and Management of Tropical Soils, P. O. Box 150, Kuala Lumpur Malaysia: 10

Marschner, H. 1995. *Mineral Nutrition of Higher Plants* (Eds.). San Diego: Academic Press

Marschner, P. 2012. *Mineral Nutrition of Higher Plants* (Eds). London: Academic Press

Mayoral, M. L., Atsmon, D., Shimshi, D. and Gromet-Elhanan, Z. 1981. Effect of Water Stress on Enzyme Activities in Wheat and Related Wild Species: Carboxylase Activity, Electron Transport and Photophosphorylation in Isolated Chloroplasts. *Functional Plant Biology* **8(5):** 385-393

McCann, J. 2009. *Maize and Grace: Africa's Encounter with a New World Crop, 1500-2000.* Cambridge: Harvard University Press

McPherson, H.G. and Boyer, J. S. 1977. Regulation of Grain Yield by Photosynthesis in Maize Subjected to a Water Deficiency. *Agronomy Journal* **69:** 714-718

Medrano, H., Escalona, J. M., Bota, J., Gulías, J. and Flexas, J. 2002. Regulation of Photosynthesis of C_3 Plants in Response to Progressive Drought: The Stomatal Conductance as a Reference Parameter. *Annals of Botany* **89(7):** 895-905

Milind, P. and Isha, D. 2013. Zea Maize: A Modern Craze. *International Research Journal of Pharmacy* **4(6):** 39–43

Ministry of Agriculture and Agro-Based Industry Malaysia. 2016. Vegetables. MOA

Mladenova, I. E., Bolten, J. D., Crow, W. T., Anderson, M. C., Hain, C. R., Johnson, D. M. and Mueller, R. 2017. Intercomparison of Soil Moisture, Evaporative Stress, and Vegetation Indices for Estimating Corn and Soybean Yields over the US. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing* **10(4):** 1328-1343

Mooi, K. C. 1990. MARDI Seberang Perai

Mostafavi, K., Geive, H. S., Dadresan, M. and Zarabi, M. 2011. Effects of Drought Stress on Germination Indices of Corn Hybrids (*Zea mays* L.). *International Journal of Agricultural Science* **1(2):**10-18

Moulia, B. 1994. The Biomechanics of Leaf Rolling. *Biomimetics (USA)* **2**: 267–281

Nayyar, H. and Gupta, D., 2006. Differential Sensitivity of C_3 and C_4 Plants to Water Deficit Stress: Association with Oxidative Stress and Antioxidants. *Environmental and Experimental Botany* **58(1):** 106–113

Nielsen, R. L. 2002. Corn Growth and Development: What Goes on from Planting to Harvest. Agronomy Department, Purdue University, West Lafayette, Indiana

Nielsen, R. L. 2015. Requirements for Uniform Germination and Emergence of Corn. West Lafayette: Purdue University

Nikju, M. B., Mobasser, H. R. and Ganjali, H. R. 2015. Influence of Variety on Biological Yield, Harvest Index, Percent of Protein in *Zea mays. Biological Forum–An International Journal* **7(1):** 662-667

Nilus, R., Maycock, C. R., Majalap-Lee, N. and Burslem, D. F. R. P. 2011. Nutrient Limitation of Tree Seedling Growth in Three Soil Types Found in Sabah. *Journal of Tropical Forest Science* **23(2):** 133-142

Noodén, L. D. (Eds.). 2012. Senescence and Aging in Plants. Elsevier

Nozulaidi, M., Nurinani, M., Khairi, M. and Jahan, S. 2016. Production of Corn; Effects of Manganese Application on Plant Parameters. *Journal of Agricultural Research* **1(2):** 1-7

Nuss, E. T. and Tanumihardjo, S. A. 2010. Maize: A Paramount Staple Crop in the Context of Global Nutrition. *Comprehensive Reviews in Food Science and Food Safety* **9(4):** 417–436

Nwachukwu, O. I. and Ikeadigh, M. C. 2012. Water Use Efficiency and Nutrient Uptake of Maize as Affected by Organic and Inorganic Fertilizer. *Production Agriculture and Technology* **8(1):** 199-208

O'toole, J. C., Cruz, R. T. and Singh, T. N. 1979. Leaf Rolling and Transpiration. *Plant Science Letters* **16(1)**: 111-114

Okalebo, J. R., Gathua, K. W. and Woomer, P. L., 1993. *Laboratory Methods of Soil and Plant Analysis: A Working Manual Tropical Soil Biology and Fertility Program.* Nairobi: TSBF Institute

Otegui, M. E., Andrade, F. H. and Suero, E. E. 2005. Growth, Water Use, and Kernel Abortion of Maize Subjected to Drought at Silking. *Field Crops Research* **40:** 87-94

Pace, P. F., Cralle, H. T., El-Halawany, S. H. M., Cothren, J. T. and Sensaman, S. A. 1999. Drought Induced Changes in Shoot and Root Growth of Young Cotton Plants. *Journal of Cotton Science* **3(4):** 183–187

Panagos, P., Meusburger, K., Liedekerke, M. V., Alewell, C., Hiederer, R. and Montanarella, L. 2014. Assessing Soil Erosion in Europe Based on Data Collected Through a European Network. *Soil Science and Plant Nutrition* **60(1):** 15-29

Pandey, R. K., Maranville, J. W. and Admou, A. 2000. Deficit Irrigation and Nitrogen Effects on Maize in a Sahelian Environment: I. Grain Yield and Yield Components. *Agricultural Water Management* **46(1):** 1-13

Parry, M. A. J., Androlojc, P. J., Khan, S., Lea, P. J. and Keys, A. J. 2002. Rubisco Activity: Effects of Drought Stress. *Annals of Botany (London)* **89(7):** 833–839

Parsons, K. J., Zheljazkov, V. D., MacLeod, J. and Caldwell, C. D. 2007. Soil and Tissue Phosphorus, Potassium, Calcium and Sulfur as Affected by Dairy Manure Application in a No-till Corn, Wheat and Soybean Rotation. *Agronomy Journal* **99(5):** 1306-1316

Pask, A. J. D., Pietragalla, J., Mullan, D. M. and Reynolds, M. P. 2012. *Physiological Breeding II: A Field Guide to Wheat Phenotyping.* CIMMYT

Peter, J., Nathan, M. and Laboski, C. 2012. pH and Lime Requirement. In Agricultural Experiment Stations of Illinois (Ed.). *Recommended Chemical Soil Test Procedures for the North Central Region.* Columbia: Missouri Agricultural Experiment Station

Pinheiro, C. and Chaves, M. M. 2010. Photosynthesis and Drought: Can We Make Metabolic Connections from Available Data? *Journal of Experimental Botany* **62(3):** 869-882

Pireivatlou, J., Qasimov, N. and Maralian, H. 2010. Effect of Soil Water Stress on Yield and Proline Content of Four Wheat Lines. *African Journal of Biotechnology* **9(1):** 36-40

Ranum, P., Peña-Rosas, J. P. and Garcia-Casal, M. N. 2014. Global Maize Production, Utilization and Consumption. *Annals of the New York Academy of Sciences* **1312(1):** 105-112

Raza, S., Farrukh Saleem, M., Mustafa Shah, G., Jamil, M. and Haider Khan, I. 2013. Potassium Applied under Drought Improves Physiological and Nutrient Uptake Performances of Wheat (*Triticum aestivum* L.). *Journal of Soil Science and Plant Nutrition* **13(1):** 175–185

Reddy, K. R., Koti, S., Davidonis, D. and Reddy, V. R. 2004. Effects of Carbon Dioxide Enrichment and Nitrogen Nutrition on Nutrient Concentration, Yield and Fiber Quality of Cotton. *Agronomy Journal* **96:** 1139-1147

Rezaeieh, K. A. and Eivazi, A. 2011. Evaluation of Morphological Characteristics in Five Persian Maize (*Zea mays* L.) Genotypes under Drought Stress. *African Journal of Agricultural Research* **6(18):** 4409-4411

Richards, R. A. 2000. Selectable Traits to Increase Crop Photosynthesis and Yield of Grain Crops. *Journal of Experimental Botany* **51(suppl_1):** 447-458

Ritchie, S. W., Hanway, J. J. and Benson, G. O. 1993. How a Corn Plant Develops. Special Report No: 48, Iowa State University. *Science and Technology Cooperative Extension Service, Ames, IW*

Rivera-Hernandez, B., Carrillo-Avila, E., Obrador-Olan, J. J., Juarez-Lopez, J. F. and Aceves-Navarro, L. A. 2010. Morphological Quality of Sweet Corn (*Zea mays* L.) Ears as Response to Soil Moisture Tension and Phosphate Fertilization in Campeche, Mexico. *Agricultural Water Management* **97(9):** 1365-1374

Ruan, J. Y., Wu, X. and Härdter, R. 1997. The Interaction between Soil Water Regime and Potassium Availability on the Growth of Tea. *Communication in Soil Science and Plant Analysis* **28(1-2):** 89-98

Russell, W. A. 1991. Genetic Improvement of Maize Yields. *Advances in Agronomy* **46:** 245–298

Sabiel, S. A., Abdelmula, A. A., Bashir, E. M. A., Khan, S., Yingying, S., Baloch, S. U. and Bashir, W. 2014. Genetic Variation of Plant Height and Stem Diameter Traits in Maize (*Zea mays* L.) under Drought Stress at Different Growth Stages. *Journal of Natural Sciences Research* **4(23):** 116-122

Sadeghipour, O. 2008. Effect of Withholding Irrigation at Different Growth Stages on Yield and Yield Components of Mung Bean (*Vigna radiata* L.) Varieties. *American Eurasian Journal of Agriculture and Environmental Sciences* **4:** 590-594

Saeidnejad, A. H., Kafi, M., Khazaei, H. R. and Pessarakli, M. 2013. Effects of Drought Stress on Quantitative and Qualitative Yield and Antioxidative Activity Of *Bunium persicum*. *Turkish Journal of Botany* **37(5):** 930–939

Saini, H. S. and Westgate, M. E. 1999. Reproductive Development in Grain Crops during Drought. *Advances in Agronomy* **68:** 59-96

Sallah, P. Y. K., Antwi, K. O. and Ewool, M. B. 2002. Potential of Elite Maize Composites for Drought Tolerance in Stress and Non-drought Stress Environments. *Journal of African Crop Science* **10:** 1–9

Sanchez, P. A. 2002. Soil Fertility and Hunger in Africa. *Science* **295(5562):** 2019-2020

Sardans, J. and Peñuelas, J. 2007. Drought Changes Phosphorus and Potassium Accumulation Patterns in an Evergreen Mediterranean Forest. *Functional Ecology* **21(2):** 191-201

Sardans, J., Bartrons, M., Margalef, O., Gargallo-Garriga, A., Janssens, I. A., Ciais, P., Obersteiner, M., Sigurdsson, B. D. and Peñuelas, J. 2017. Plant Invasion is Associated with Higher Plant–Soil Nutrient Concentrations in Nutrient-Poor Environments. *Global Change Biology* **23(3):** 1282-1291

SAS Institute Inc. 2002. SAS Version 9.4. SAS Institute. North Carolina (USA)

Schichnes, D., Schneeberger, R. and Freeling, M. 1997. Induction of Leaves Directly from Leaves in the Maize Mutant Lax Midrib1-O. *Developmental Biology* **186(1):** 36-45

Scott, S. J., Jones, R. A. and Williams, W. A. 1984. Review of Data Analysis Methods for Seed Germination. *Crop Sciences* **24(6):** 1192-1199
Season. *Agronomy Journal* **54(3):** 217-222

Setter, T. L., Flannigan, B. A. and Melkonian, J. 2001. Loss of Kernel Set due to Water Deficit and Shade in Maize. *Crop Science* **41(5):** 1530-1540

Shabala, S. N. and Lew, R. R. 2002. Turgor Regulation in Osmotically Stressed Arabidopsis Epidermal Root Cells. Direct Support for the Role of Inorganic Ion Uptake as Revealed by Concurrent Flux and Cell Turgor Measurements. *Plant Physiology* **129(1):** 290–299

Shamshuddin, J., Che Fauziah, I. and Bell, L. C. 2009. Soil Solution Properties and Yield of Corn and Groundnut Grown on Ultisols as Affected by Dolomitic Limestone and Gypsum Applications. *Malaysian Journal of Soil Science* **13:** 1-12

Shamshuddin, J., Che Fauziah, I. and Sharifuddin. H.A.H. 1991. Effects of Limestone and Gypsum Applications to a Malaysian Ultisol on Soil Solution Composition and Yield of Maize and Groundnut. *Plant and Soil* **134:** 45-52

Shao, H. B., Chu, L. Y., Shao, M. A., Jaleel, C. A. and Hong-mei, M. 2008. Higher Plant Antioxidants and Redox Signaling under Environmental Stresses. *Comptes Rendus Biologies* **331(6):** 433-441

Sharma, K. D., Nandwal, A. S. and Kuhad, M. S. 1996. Potassium effects on CO2 exchange, ARA and yield of clusterbean cultivars under water stress. *Journal of Potassium Research* **12:** 412-423

Sharma, S. S. and Dietz, K. J. 2006. The Significance of Amino Acids and Amino-acid Derived Molecules in Plant Responses and Adaptation to Heavy Metal Stress. *Journal of Experimental Botany* **57(4)**: 711-726

Sharma, S., Duveiller, E., Basnet, R., Karki, C. B. and Sharma, R. C. 2005. Effect of Potash Fertilization on Helminthosporium Leaf Blight Severity in Wheat, and Associated Increases in Grain Yield and Kernel Weight. *Field Crops Research* **93(2):** 142–150

Shi, J., Gao, H., Wang, H., Lafitte, H. R., Archibald, R. L., Yang, M., Hakimi, S. M., Mo, H. and Habben, J. E. 2017. ARGOS8 Variants Generated by CRISPR-Cas9 Improve Maize Grain Yield under Field Drought Stress Conditions. *Plant Biotechnology Journal* **15(2):** 207-216

Sikuku, P. A., Netondo, G. W., Onyango, J. C. and Musyimi, D. M. 2010. Chlorophyll Fluorescence, Protein and Chlorophyll Content of Three NERICA Rain-fed Rice Varieties under Varying Irrigation Regimes. *ARPN Journal of Agricultural and Biological Science* **5(2):** 19-25

Sinar Harian. 2016. Maize Cultivation to be Expanded. *Sinar Harian*, 23 June, 13

Singh, D. K., Sale, P. W. G., Pallaghy, C. K. and Singh, V. 2000. Role of Proline and Leaf

Smith, M., Kivumbi, D. and Heng, L. K. 2002. Use of the FAO-CROPWAT Model in Deficit Irrigation Studies. In *Deficit irrigation practices.* FAO Water Reports No. 22, Rome, Italy

Sokoto, M. B. and Muhammad, A. 2014. Response of Rice Varieties to Water Stress in Sokoto, Sudan Savannah, Nigeria. *Journal of Biosciences and Medicines* **2:** 68-74

Subashri, M., Robin, S., Vinod, K. K., Rajeswari, S., Mohanasundaram, K. and Raveendran, T. S. 2009. Trait Identification and QTL Validation for Reproductive Stage Drought Resistance in Rice using Selective Genotyping of near Flowering RILs. *Euphytica* **166(2):** 291–305

SWI. Field Corn Seed Crop Inspection Procedures. In: *Seed Program Specific Work Instruction.* 1 April 2015.

Szőke, C., Zsubori, Z., Pók, I., Rácz, F., Illés, O. and Szegedi, I. 2002. Significance of the European Corn Borer (*Ostrinia nubilalis* Hübn.) in Maize Production. *Acta Agronomica Hungarica* **50(4):** 447-461

Tabanao, D. A. and Bernardo, R. 2005. Genetic Variation in Maize Breeding Populations with Different Numbers of Parents. *Journal of Crop Science* **45(6):** 2301-2306

Tan, K. H. 1996. Determination of Soil Water. In Tan, K. H. *Soil Sampling, Preparation, and Analysis.* New York: Marcel Decker Incorporation

Tjus, S. E., Moller, B. L. and Scheller, H. V. 1998. Photosystem I is an Early Target of Photoinhibition in Barley Illuminated at Chilling Temperatures. *Journal of Plant Physiology* **116(2):** 755-764

Tripathi, K. K., Warrier, R., Govila, O. P. and Ahuja, V. 2011. Biology of *Zea mays* (Maize). *Department of Biotechnology, Ministry of Science and Technology and Ministry of Environment and Forests, Government of India*

Turgut, I., Duman, A., Bilgili, U. and Acikgoz. E. 2005. Alternate Row Spacing and Plant Density Effects on Forage and Dry Matter Yield of Corn Hybrids (*Zea mays* L.). *Journal of Agronomy and Crop Science* **191(2):** 146–151

Ul-Allah, S., Khan, A. A., Fricke, T., Buerkert, A. and Wachendorf, M. 2014. Fertilizer and Irrigation Effects on Forage Protein and Energy Production under Semi-Arid Conditions of Pakistan. *Field Crops Research* **159:** 62-69

Umar, S. 2006. Alleviating Adverse Effects of Water Stress on Yield of Sorghum, Mustard and Groundnut by Potassium Application. *Pakistan Journal of Botany* **38(5):** 1373-1380

Upadhyaya, H. D., Wang, Y. H., Gowda, C. L. L. and Sharma, S. 2013. Association Mapping of Maturity and Plant Height using SNP Markers with the Sorghum Mini Core Collection. *Theoretical and Applied Genetics* **126(8):** 2003–2015

USDA, Soil Survey Staff. 1975. *Soil Taxonomy.* Agriculture Handbook 436. Soil Conservation Service. Washington, D. C.

USDA. 2017. GAIN report. Grain and Feed Annual Malaysia. Report No: MY7001

Vajrabhaya, M., Kumpun, W. and Chadchawan, S. 2001. The Solute Accumulation: The Mechanism for Drought Tolerance in RD23 Rice (*Oryza sativa* L.) Lines. *Science Asia* **27**: 93-97

Valerie, P. and Moses, N. 2016. Effect of Waterlogging on Selected Morphological Characteristics in Maize. *Journal of Agricultural Science and Food Technology* **2(6):** 80-92

Verbruggen, N. and Hermans, C. 2008. Proline Accumulation in Plants: A Review. *Amino Acids* **35(4)**: 753-759

Wang, M., Zheng, Q., Shen, Q. and Guo, S. 2013. The Critical Role of Potassium in Plant Stress Response. *International Journal of Molecular Sciences* **14(4):** 7370-7390

Wang, W. H., Yi, X. Q., Han, A. D., Liu, T. W., Chen, J., Wu, F. H., Dong, X. J., He, J. X., Pei, Z. M. and Zheng, H. L. 2012. Calcium-sensing Receptor Regulates Stomatal Closure through Hydrogen Peroxide and Nitric Oxide in Response to Extracellular Calcium in Arabidopsis. *Journal of Experimental Botany* **63(1):** 177-190

Wang, W., Vinocur, B. and Altman, A. 2003. Plant Responses to Drought, Salinity and Extreme Temperature: Towards Genetic Engineering for Stress Tolerance. *Planta* **218(1):** 1–14

Wilhelm, W. W., Ruwe, K. and Schlemmer, M. R. 2000. Comparisons of Three Leaf Area Index Meters in a Corn Canopy. *Crop Science* **40(4):** 1179-1183

Xoconostle-Cázares, B., Ramírez-Ortega, F. A., Flores-Elenes, L. and Ruiz-Medrano, R. 2010. Drought Tolerance in Crop Plants. *American Journal of Plant Physiology* **5(5):** 1-16

Yang, F., Xu, X., Xiao, X. and Li, C. 2009. Responses to Drought Stress in Two Poplar Species Originating from Different Altitudes. *Biologia Plantarum* **53(3):** 511-516

Zaharah, H. 1992. Morfologi dan Varieti-varieti Jagung. In Zaharah, H. (Ed.). *Penanaman Jagung.* Serdang: MARDI. 7-12

Zarabi, M., Alahdadi, I. and Akbari, G. A. 2011. A Study on the Effects of Different Biofertilizer Combinations on Yield, its Components and Growth Indices of Corn (*Zea mays* L.) under Drought Stress Condition. *African Journal of Agricultural Research* **6(3):** 681-685

Zhang, J., Jia, W., Yang, J. and Ismail, A. M. 2006. Role of ABA in Integrating Plant Responses to Drought and Salt Stresses. *Field Crops Research* **97(1):** 111-119

Zhang, L., Gao, M., Li, S., Alva, A. K. and Ashraf, M. 2014. Potassium Fertilization Mitigates the Adverse Effects of Drought on Selected *Zea mays* Cultivars. *Turkish Journal of Botany* **38(4):** 713-723

Zhao, D., Oosterhuis, D. M. and Bednarz, C. W. 2001. Influence of Potassium Deficiency on Photosynthesis, Chlorophyll Content, and Chloroplast Ultrastructure of Cotton Plants. *Photosynthetica* **39(1):** 103-109

Zhu, X., Gong, H., Chen, G., Wang, S. and Zhang, C. 2005. Different Solute Levels in Two Spring Wheat Cultivars Induced by Progressive Field Water Stress at Different Developmental Stages. *Journal of Arid Environments* **62(1):** 1–14