SOIL SCIENCE CONFERENCE OF MALAYSIA 2013

Good Agriculture Practice (GAP) For Soil Health Sustainability

# PROCEEDINGS OF SOILS 2013

BUKIT GAMBANG RESORT CITY, GAMBANG, PAHANG

16th -18th APRIL 2013


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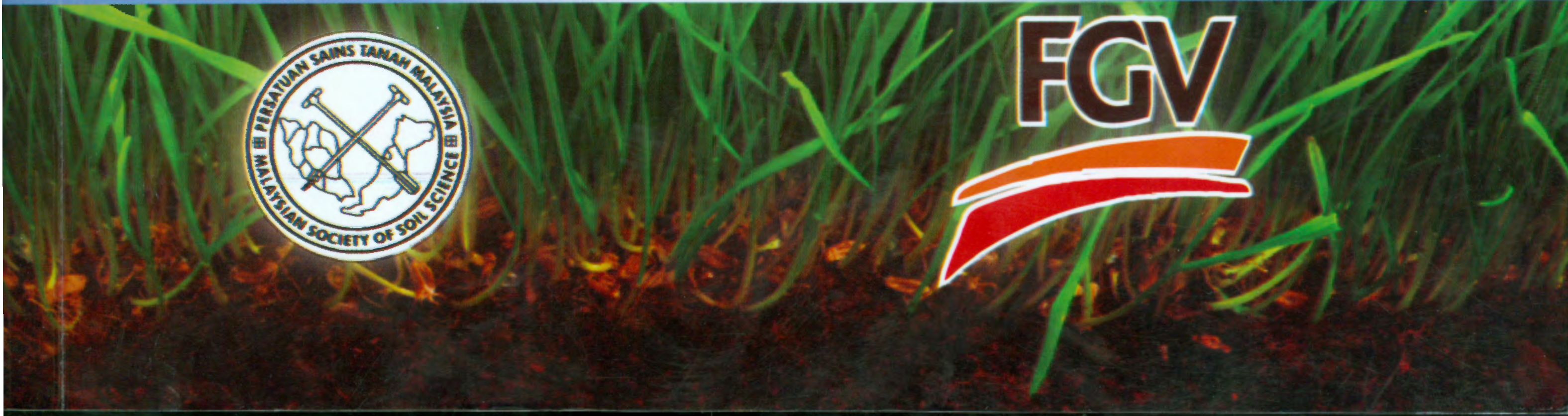

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# THE ROLE OF ORGANIC FERTILIZERS AND DRIP IRRIGATION FREQUENCY ON THE BIOMASS AND YIELD COMPONENTS OF SWEET CORN UNDER AN ACID SOIL CONDITIONS

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## INTRODUCTION

Sweet corn (*Zea mays L*) is a multi-uses cereal crops which belongs to the family *Poaceae* and cultivated as an annual field crops over the world (Remison 2005). Corn is one of the important staple crops in semi-arid regions particularly in Sub-Sahara Africa due to its short harvesting period, high yielding capacity, easy management and processing compared with the other crops. According to the cereal production in the world, corn ranks second to wheat (Jaliya *et al.* 2008). Globally, the United States leads the corn production (39%) followed by China and Brazil (Shultz 2008).

Drip irrigation is one of the most important irrigation methods to minimize water used in agricultural sector and optimizing corn productivity (El-Hendawy *et al.* 2008). Therefore, water frequency is an important factor in drip irrigation management because it influences soil moisture regime, water and root distributions around the emitter, amount of water percolates under the root zone, and the amount of water uptakes by roots (Assouline 2002).

Not only water availability can limit crop productivity, also lack of soil nutrients especially macronutrients are the major limiting factor for crop productivity (Gutierrez *et al.* 2008). To sustain the quality and the quantity of the crop prodution, maintaining and improving soil fertility is important and this is done through application of fertilizers either inorganic or organic forms (Efthimiadou *et al.* 2010). Adenyan (2005) reported that the main purposes for the fertilizer application of any crop is to achieve high yield, and improve soil fertility. However, chemical fertilizers are expensive. So farmers turn to organic fertilizers as the source of nutrients. The objectives of this study was to determine the effect of drip irrigation frequencies and fertilizer sources on the growth and yield of sweet corn planted on an acid soil.

## MATERIALS AND METHODS

### *Experimental Site*

The study was conducted at Field 2, Faculty of Agriculture, Universiti Putra Malaysia. The experimental site is located at an altitude of 30 m above sea level, with latitude of 30.0094°N and longitude of 101.70°E. Plants were sown under rain shelter to prevent rainwater interference. The soil was Serdang series classified as Ultisol (Soil Survery Staff 2010) and the physico-chemical characteristics of untreated soils are given in Table 1.

***Experimental design***
All treatments in this study were arranged in a split plot design with four replications. Irrigation treatments were assigned as the main plot, while fertilizer sources as sub-plot factor. Drip irrigtion was used in this study since it is the most efficient irrigation system in terms of water safety and management. Four drip irrigation frequencies were used which is: daily irrigation (I1), one day irrigation interval (I2), two days irrigation interval (I3) and three days irrigation interval (I4). Four fertilizer sources established are: straight NPK fertilizer (urea, triple super phosphate and muriate of potash), goat manure, poultry manure and without fertilizer (control). The fertilizers were applied based on sweet corn requirements recommended by the Malaysian Agricultural Research and Development Institute (MARDI), which is (120:60:90 kg $ha^{-1}$) of NPK, respectively. Both organic and inorganic fertilizers were applied during the planting time except urea (N) which was applied 50% during the planting and another 50% at 30 days after sowing (DAS). Split application of nitrogen fertilizer reduces leaching and volatilization losses of N (Das,1993). In this study, water was suplied to the sweet corn as 100, 90, 80 and 70% of soil water field capacity for irrigation I1, I2, I3 and I4, respectively.

The drip irrigation system used main water source from which the water comes through polypipes (32mm) then it was distributed to the polybags by microtubes. The valves control water passage and synchronized with irrigation schedules, while small dripper was installed at the end of each microtube. Soil water content was measured using 10HS Soil Moisture Sensor (USA).

***Data collection***
Soil physical and chemical characteristics were analysed prior to planting and results are presented in Table 1. Plants were measured for both growth and yield parameters such as cholorphyll content, total dry matter yield (TDMY), number of ear per plant, ear and cob weight per plant, ear diameter, ear length and 100 grain weight. To determine the amount of nutrient taken by the leaves and roots, plant tissue analysis was done on the dried and ground leaves and root using wet ashing method.

Table 1: Physico-chemical characteristic of untreated soil (topsoil)

| Parameters | Values |
|---|---|
| pH | 4.8 |
| EC ($mScm^{-1}$) | 0.14 |
| CEC (cmolc $kg^{-1}$) | 16.9 |
| Total N % | 0.84 |
| Total C% | 1.23 |
| Available P (mg $kg^{-1}$) | 54.8 |
| Exchangeable (cmolc $kg^{-1}$) | |
| Ca | 0.22 |
| Mg | 0.55 |
| K | 0.24 |
| Al | 0.33 |
| Particle size distribution (%) | |
| Sand | 56.13 |
| Silt | 8.24 |

| | |
|---|---|
| Clay | 35.54 |
| Bulk density BD ($gcm^{-3}$) | 1.3 |
| Porosity (%) | 52.3 |
| Moisture content (MC) | 12.5 |
| Field capacity (%) | 18.2 |
| Wilting point (WP) % | 12.7 |

***Statiscal analysis***

All the data collected from this study were analysed using analysis of variance (Anova) and the difference between means was compared using Duncan's Multiple New Range Test (DMNRT) using SAS software version 9.2 (1984).

## RESULTS AND DISCUSSION

Interaction of irrigation frequency and fertilizer sources on total dry matter yield (shoot and root dry weight) is presented in Figures 1 and 2, respectively. Statistical analysis indicates that both irrigation frequency and fertilizer sources significantly ($P<0.01$) affecting the total shoot dry weight (all above ground except grains), where the highest weight was recorded from the daily irrigation frequency with goat manure (GM) (Figure 1). Similarly, interaction between these two parameters had significant ($<0.05$) effect on root dry weight as shown in Figure 2. Highest root dry weight was found with I2 combined with poultry manure. Poultry manure greatly improved root dry weight while control treatment recorded the lowest value.

Our results showed that both shoot and root dry weights significantly increased with increasing irrigation frequency, meaning high irrigation frequency has positive effect on the growth of sweet corn as soil water duration at the root zone is longer compared with low irrigation frequency. Similar result was reported by EL-Hendawy (2008) where available soil moisture was higher in a high irrigation frequency than a low irrigation frequency. Longer moist condition at root zone area encourages root hairs to develop and subsequently the shoots also develop. The higher reduction of the dry yield with lower irrigation frequency especially in I4 might be due to water deficit occurring at a very critical growth stage of corn. Water stress occurred at low irrigation frequency because the amount of water applied at each irrigation frequency was higher than soil moisture storage capacity, thus portion of the applied water may not be used by the plant and most likely drained down. Therefore, the amount of stored water in the root zone was less than the time over which the plants take up water (Phene *et al.* 1991; Coelho, 1999; Assouline *et al.* 2002). On the other hand, the result showed that inorganic fertilizers have less effect on the biomass of sweet corn especially in the low irrigation frequency than the organic fertilizer. This might be caused by N leaching effect following continuous availability of soil moisture. Whereas organic fertilizer has dual benefit, as fertilizer to supply nutrients and as mulch to improve soil structure and retained soil moisture.

The yield components of the study namely ear weight, cob weight, ear length, ear diameter and 100 grain weight are presented in Table 2. Irrigation frequency and fertilizer sources significantly ($P<0.05$) influenced ear weight, cob weight and 100 grain weight, but irrigation frequency alone did not affect ear length and ear diameter. The highest ear and cob weights were observed for irrigation two (I2) which was once in 2 days and irrigation one 'daily irrigation' (I1) (149.35, 145.82 and

106.04, 92.49 g/plant, respectively) while the lowest ear and cob weights were found from irrigation three (I3) and four (I4) which were 124.97, 126.44 and 88.1, 68.53 g/plant, respectively. In the case of fertilizer source, NPK significantly improved the ear and cob weights compared with poultry and goat manure, while the lowest ear and cob weights were from unfertilised treatment (control). Irrigation frequency significantly affected the 100 grain weight of sweet corn and the highest weight was from I1 and I2. The current study showed that yield parameters affected by the water stress at tasseling stage were number of ears and grains per plant, while after pollination water stress highly decreased the size of the grain (El-Hendawy *et al.* 2008). This is why I3 and I4 have a lower grain weight compared to I1 and I2 (Table 3). On different fertilizer sources, NPK and GM significantly improved the 100 grain weight compared with PM, but all fertilizers performed better than the control. The highest 100 grain weight was recorded from NPK and GM (21.99g and 1.55 g, respectively) followed by PM (15.08g) and the control (14.4g) (Table 2).

The present study demonstrated that yield components increased with increasing irrigation frequency especially with daily irrigation (I1) and once in 2 days irrigation (I2) due to the optimum availability of soil moisture. Sandy clay soil promotes growth of the plants when the root zone is wet. However, in low irrigation frequency, sandy clay soil has poor ability to store soil moisture for longer period without irrigation resulting in water deficit. Therefore, reduction of the yield parameters in low irrigation intervals is caused by water stress occurring during critical growth stage such as tasseling and filling grain stages (Sinclair *et al.* 1990; Traore *et al.* 2000; Stone *et al.* 2001).

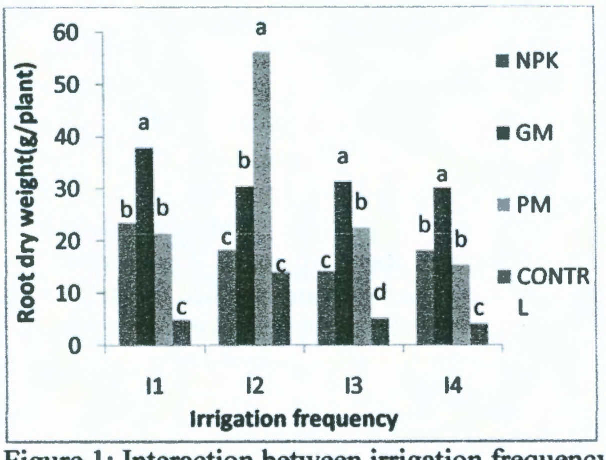


Figure 1: Interaction between irrigation frequency and fertilizer source on corn Root dry weight

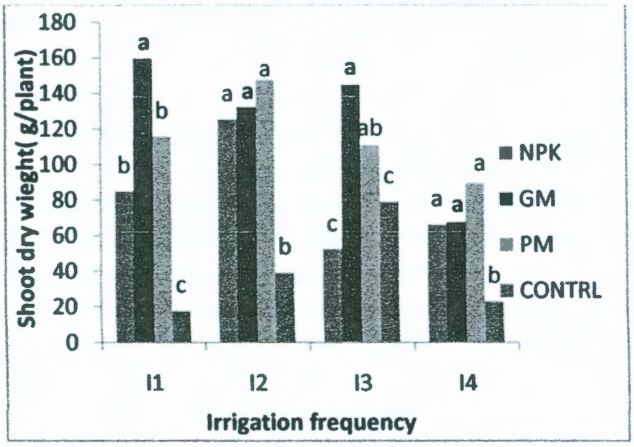


Figure 2: Interaction between irrigation frequency
and fertilizer source on corn shoot dry weight

NOTE; [ I1: daily irrigation, I2: once in 2 days, I3: once in 3 days, I4: once in 4 days, NPK (Urea, Triple superphosphate, Muriate of potash), GM: goat manure, PM: poultry manure]

Table 2. Effects of irrigation frequency and fertilizer sources on yield components

| Treatments | Ear weight | Cob weight | Ear length | Ear diameter | 100grain weight |
|---|---|---|---|---|---|
| Irrigation frequency(I) | | | | | |
| I1 (daily irrigation) | 145.82a | 92.49a | 28.31a | 40.20a | 17.25a |
| I2 (once in 2 days) | 149.35a | 106.04a | 30.13a | 43.91a | 17.18a |
| I3 (once in 3 days) | 124.97b | 68.53b | 29.50a | 39.89a | 11.55b |
| I4 (once in 4 days) | 126.44b | 88.15a | 27.34a | 38.97a | 14.43ab |
| Fertilizer sources | | | | | |
| NPK | 183.20a | 125.91a | 31.94a | 46.11a | 21.99a |
| GM (goat manure) | 143.15c | 96.99b | 29.63a | 43.05a | 21.57a |
| PM (poultry manure) | 162.61b | 101.84b | 29.31a | 42.79a | 15.08b |
| CTRL (control) | 57.63d | 30.48c | 24.44b | 31.02b | 3.77c |

## CONCLUSION

Outputs from this study revealed that high irrigation frequency (I1 and I2) has positive effect on the corn biomass, while fertilizer (organic and inorganic) sources significantly improved total dry matter especially with high drip irrigation frequency. However, organic fertilizers (goat and poultry manure) produced more biomass compared with mineral fertilizers and contributed to soil quality improvements with better moisture availability.

The yield components were also significantly affected by the drip irrigation frequency and fertilizer sources especially the ear, cob and 100 grain weights. Therefore based on this study, daily or once in 2 days drip irrigation frequency with organic fertilizers are recommended for the acid Ultisols under tropical conditions.

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