International Journal of Agriculture and Environmental Research

ISSN: 2455-6939

Volume: 06, Issue: 06 "November-December 2020"

ASSESSMENT OF GROUND WATER CONDITIONS AND RESPONSE PHYSIOLOGY OF MUNG BEAN PLANT DURING STOPPING OF WATER

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DOI: https://doi.org/10.51193/IJAER.2020.6603

ABSTRACT

This study aims to determine soil moisture content when the mung bean plants experience permanent wilting and assessment of the physiological response of the mung bean plants when not given water. The characteristics analyzed were: soil moisture content, plant witheredness, proline content, plant height, and number of leaves. All evaluated characteristics reachedin the early vegetative phase, mung bean plants do not experience wilting; in the early generative phase, the soil moisture content when the mung bean plant withers is 18.20 %; if the soil moisture content decreases, are higher the proline level, plant height, and number of leaves.

Keywords: soil moisture content, physiological response, mung bean

INTRODUCTION

Mung beans are one of the agricultural commodities that have good prospects for development in Indonesia. Mung beans are the third most important legume crop after soybeans and peanuts. One of the causes is the increasing demand for consumption and processed industries (Ministry of Agriculture, 2012). Mung beans are a secondary crop, have advantages over other food crops, namely early age (55-65 days), water requirements for growth are 700-900 mm/ year, can be planted on less fertile land, and can be used as soil fertilizers.

According to Sumarji (2013), the productivity of mung beans at the farmer level is only 0.7 tons/ ha, whereas at the research level, the productivity is 2 tons/ ha. The factors that cause low productivity of mung beans at the farmer level are: (1) lack of availability of superior varieties, (2) suboptimal farming techniques, (3) disturbance of plant pests (OPT), (4) socio-economic constraints, (5) climate change, and (6) excess or lack of water (water stress).

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Drought induces cell damage (Levitt, 1980). Drought is a term to state that plants experience water shortages due to limited water from the growing medium. Drought in a long time is called drought stress. When 60% of the water from the root layer has been used, plants will show symptoms of drought (Kuswantoro, et al., 2011). Drought stress results in changes in morphology, physiology, and biochemistry, which adversely affect plant growth and yield. Drought stress in plants can be caused by insufficient water supply in the root zone and excessive water demand by leaves due to evapotranspiration rates that exceed water absorption rates even when sufficient groundwater is available (Levitt, 1980).

The effect of water stress on plant physiology depends on the level of stress experienced and the type or cultivar planted. The initial effect of plants that are stressed by lack of water is the occurrence of obstacles to the opening of leaf stomata which then has a major effect on physiological and metabolic processes in plants. The results of Sianipar et al. (2013) study stated that the highest number of mung bean pods per plant was found in the 100% drought stress treatment, the field capacity was 2.03 pods, while the lowest was found in 40% of the field capacity of 1.57 pods. The results of Lapanjang et al. (2008) research show that the weight of dry plants (stems, leaves, roots) decreases with increasing drought stress. Furthermore, Lapanjanget al.(2008), at groundwater content of 60% field capacity (KL) dry stem weight, dry leaves, dry shoots, and dry plants (total) respectively 33.99; 23.19; 28.0 and 27.08%, while the soil moisture content was 40% field capacity, dry stem weight, dry leaves, dry shoots, and dry plants (total) 74.96 respectively; 76.56; 75.85; and 74.87%.

According the adverse effects of drought, it is necessary to study the critical period of mung beans plants and its impact on physiological responses to obtain drought tolerant varieties. The aim of this research was to determine the water content of the soil when the mung bean plants experienced permanent wilting, and to study the physiological responses of the plants during the absence of water.

MATERIAL AND METHODS

The experiment was conducted on greenhouse at Sidabowa village, sub-district of Patikraja, district of Banyumas, Central Java, Indonesia (7º 45’ S, 109º 21’ W; 75 m a.s.l). The experiment was carried out by planting mung beans in a pot containing 18.75 kg of soil (oven dry equivalent). This study used a non-factorial randomized complete block design (RAKL).The treatments tested were potting soil without plants (T0) and potting soil with plants (T1).

Six pots of soil without plants and 6 pots of soil with plants for the early vegatative phase of observation, six pots of soil without plants and 6 pots of soil with plants for observation of the early generative phase, and 6 pots of soil without plants and 6 pots of soil with plants for observation of the filling seeds phase.

The observation pots of early vegetative phase, early generative phase and filling seeds phase are maintained at field capacity. In observation of early vegatative phase, after 6 days of age, the water supply was stopped until the age of 16 days. In the observation of early generative phase, after 26 days of age, water supply was stopped until the age of 35 days. In the observation of the filling seeds phase, after 46 days of age, the water supply was stopped until the age of 55 days.

The variables observed in each phase were soil moisture content, plant witheredness, proline content, plant height, and number of leaves. Observation data were analyzed by regression analysis.

RESULTS AND DISCUSSION

Soil moisture content and plant witheredness of mung bean at each phase are shown in Table 1.

Table 1: Soil moisture content and plant witherednessof mung bean

Day of observation	Early vegetative phase		Early generative phase		Filling seed phase	
	Soil moisture content (%)	Plant witheredness	Soil moisture content (%)	Plant witheredness	Soil moisture content (%)	Plant witheredness
1	44.96	F	27.90	F	16.54	PW
2	44.19	F	27.28	F	14.09	PW
3	43.60	F	25.13	F	13.83	PW
4	42.55	F	24.10	F	13.61	PW
5	41.99	F	23.27	F	13.29	PW
6	40.95	F	22.02	F	13.09	PW
7	40.02	F	21.48	F	10.88	PW
8	39.22	F	20.49	F	10.58	PW
9	38.54	F	19.43	F	10.24	PW
10	37.36	F	18.20	PW	10.03	PW

F: Fresh; PW: Permanent Wilt

Based on Table 1, mung bean does not experience wilting in the early vegetative phase. the soil moisture content is still sufficient for plant growth in early vegetative phase. In early generative phase, the soil moisture content when the mung bean plant withers is 18.20 %. The decrease in soil moisture content is caused by water evaporation in the soil and plants, resulting in drought stress. This is in line with Prihastanti (2010) which states that one of the causes of drought stress is high evaporation which exceeds the supply of groundwater to the roots. The soil moisture content of 18.20 % is not sufficient for plant growth.

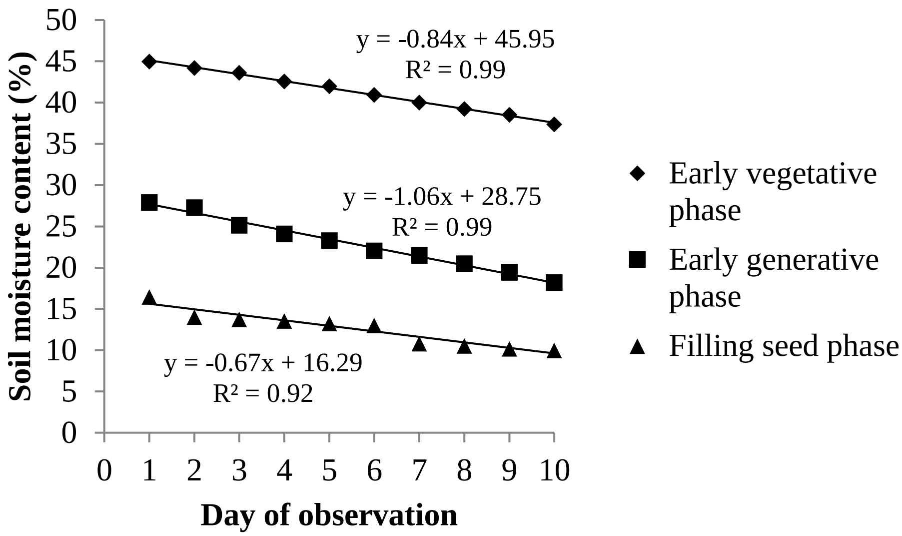

Figure 1: Soil moisture content at each growth phase of mung bean

Figure 1 shows a decrease in soil moisture content at each growth phase. This decreasing soil moisture content indicates that as long as water supply is stopped, the weight of groundwater decreases. Reduction in groundwater weight is caused by evaporation of water through the soil surface and plants. According to Jaleel et al. (2009) the availability of ground water decreases and atmospheric conditions cause continuous water loss through transpiration or evaporation.

The decrease in soil moisture content in the initial generative phase is due to the extraction of groundwater by roots due to plant demand, while the availability of groundwater does not increase (Sowmen, 2013). In the early generative phase, the rate of reduction in soil moisture content is faster than the early vegetative phase because the plants are getting bigger, so they need more water.

Stopping water supply during the filling seed phase, mung bean plants have reached a permanent wilt point. This permanent wilting point indicates that the soil moisture content is not sufficient for the growth of mung bean plants. This is because on days 46 to 55 the groundwater content is 16.54% and continues to decline to 10.03%. The soil moisture content at the point of permanent wilting is 24.01%, the soil moisture content on days 46 to 55 is below the point of permanent wilt. This fact shows that the roots of mung beans plants cannot absorb water, and this is the plant that has experienced drought stress. Plant roots cannot absorb groundwater because the

ISSN: 2455-6939

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attractive force between water and soil is greater than the attractive force between roots and water (Rusyani, 2014). In addition, due to lack of water supply in the root area (excessive water demand by leaves) due to the rate of evapotranspiration (Song et al., 2011).

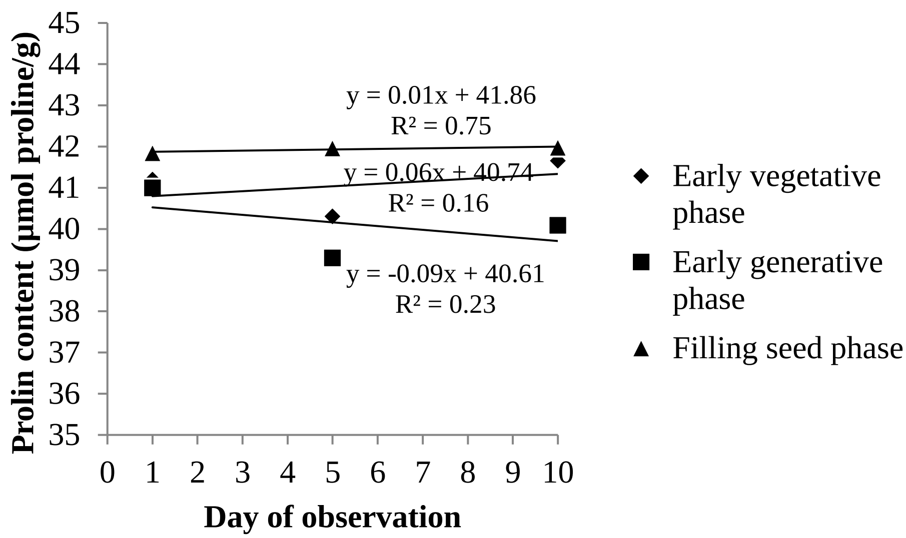

Figure 2: Proline content at each growth phase of mung bean

There was an increase in proline levels because the soil moisture content decreased (Figure 2). In conditions of water shortage, plants respond to cell osmotic adjustment by producing proline compounds (Hidayat, 2005). In drought-stressed conditions glutamic acid is a precursor to proline formation via the glutamic acid pathway. Glutamate kinase phosphorylase and pyrroline-5-carboxylate synthetase (P5CS) catalyze the conversion of glutamic acid to glutamyl phosphatase which is then further reduced to glutamate semialdehyde (GSA) by the action of the enzymes glutamyl phosphate reductase and P5CS. Furthermore, through the cyclation process that occurs spontaneously, there is a change in glutamate semialdehyde to pyrroline-5-carboxylate (P5C). Pyrroline-5-carboxylate reductase (P5CR) enzymes convert P5C to proline. Ronde et al. (2000) stated that the decrease in groundwater content can cause plants to induce proline to maintain cell turgor pressure. This is also supported by the statement of Heldt (2005), that proline functions as a protective substance against leaf damage when dehydration occurs.

Table 2 shows the effect of soil water content on plant height and number of leaves. Plant height and number of leaves continued to increase despite a decrease in soil moisture content. The increase in plant height ang number of leaves in the early vegetative phase is due to efficient absorption of nutrients and water, as well as light, which indicates that more photosynthate is obtained for growth, thus extending and adding to the internodes in plants. Gardner et al. (1991) stated that the vegetative growth stage, drought stress can inhibit plant height, leaf formation,

ISSN: 2455-6939

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and increase in leaf area. According to Zulfita (2012) that in the vegetative growth stage, water is used by plants for cell division and enlargement which is manifested in plant height increase and leaf propagation.

Table 2: Plant height and number of leaves of mung bean

Day of observation	Early vegetative phase Plant height (cm)	Early vegetative phase Number of leaves (sheet)	Early generative phase Plant height (cm)	Early generative phase Number of leaves (sheet)	Filling seed phase Plant height (cm)	Filling seed phase Number of leaves (sheet)
1	6.10	3	26.20	13	50.20	21
2	6.40	3	27.00	14	50.20	21
3	7.00	4	27.60	15	50.20	21
4	7.40	4	28.10	18	50.20	21
5	7.80	5	29.00	20	50.20	21
6	8.40	5	29.50	21	50.20	21
7	9.00	6	30.20	22	50.20	21
8	10.00	6	31.00	23	50.20	21
9	11.00	7	32.50	24	50.20	21
10	11.40	7	33.00	25	50.20	21

Addition of plant height and number of leaves still occurs until the early generation phase. This means that at the stage of plant development, stopping water supply does not affect the uptake of certain nutrients. Tambunan (2009) states that plants need sufficient nutrients for the photosynthesis process to produce photosynthate and assimilates which plants will use for vegetative growth.

CONCLUSION

All evaluated characteristics reached in the early vegetative phase, mung bean plants do not experience wilting; in the early generative phase, the soil moisture content when the mung bean plant withers is 18.20 %; if the soil moisture content decreases, are higher the proline level, plant height, and number of leaves.

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