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PHYSIOLOGICAL RESPONSE OF PEARL MILLET UNDER MOISTURE GRADIENT

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ABSTRACT

Drought response of pearl millet, often grown in semiarid and tropical regions with limited amount and duration of rainfall, was studied in the field with four levels of moisture gradient using line-source sprinkler system. Moisture stress effects on the physiological aspects of crop growth were analysed to determine relationships with grain yiled and to evaluate possible drought avoidance mechnaisms. Increasing mositure stress resulted in progressively less Leaf Area (LA), Leaf Area Duration (LAD) and shoot dry matter. Conversely, Specific Leaf Weight (SLW) increased with increased levels of stress. Variation in moisture regime has significantly influenced the grain yield.

Water deficits reduce the potential yield of crops. The magnitude of the reduction varies according to the degree of interaction between the stress and such variables as stage of life cycle, planting density, genotype and previous adaptation to drought. Most crops of pearlmillet are grown under conditions of limited irrigation or rainfall. It can be said that pearlmillet belongs to a class of crop plants that can survive fairly under severe water deficits and still produce a modest yield. The present study is aimed to fix up optimum water requirement for increased yield employing various moisture gradient through wet to dry regimes.

MATERIALS AND METHODS

In order to evaluate the physiological functions responsible for the yield differences, this field experiement was conducted during June-August, 1984 with cumbu (Cv.Co.6). The plants were subjected to different moisture gradient using line-source sprinkler irrigation. The trial was conducted in RBD with six replications following regular cultural practices.

Total dry matter production was recorded at the time of harvest. Leaf area was measured using an automatic area meter (LX-3000). Specific leaf weight was determined at 50 per cent flowering (40 days after emergence) dividing leaf dry weight by leaf area. Leaf area duration was computed as described by Radford (1967).

Observations on plant water status such as leaf temperature, transpiration rate and leaf diffusive resistance were taken using LI-COR Steady State Porometer (Model LI-1600) and Canopy temperature was measured with infrared thermometer (Model Telatemp AG-42). All these observations were made at 50 per cent flowering between 13.00 and 14.00 hrs.

RESULTS AND DISCUSSION

Moisture stress effects on total dry matter production

It is observed that the TDMP were linearly related to the water applied ($r = 0.94$) suggesting that the moisture stress adversely affected the TDMP reducing the values from 10 (M_2) to 24 (M_4) per cent over wet regime (M_1).

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Table 1. Effect of various moisture regimes on growth, yield and water use efficiency in pearl millet

Moisture regime	Irrigation water applied (mm)	Total leaf area (sq.cm.)	Leaf area duration (days)	Specific leaf weight ($mg.cm^{-2}$)	Grain yield ($kg.ha^{-1}$)	Water use efficiency (kg/ha/mm)	Harvest Index
M1	290	1254.89	66	3.85	4570	15.76	0.30
M2	233	1172.08	59	4.29	4433	19.03	0.27
M3	212	1100.15	49	4.92	5208	24.57	0.38
M4	155	1030.61	42	5.30	4608	29.73	0.32
CD at 5%	-	104.43	-	0.14	188	-	-

Table 2. Plant water status in pearl millet under moisture gradient

Moisture regime	Canopy temperature °C	Leaf temperature °C	Leaf difusive resistance (Sec. cm^{-1})	Transpiration rate $\mu g.\ H_2O.\ cm^{-2}\ sec^{-1}$
M_1	27.5	33.4	1.115	27.8
M_2	27.9	35.3	1.130	27.0
M_3	28.2	35.8	1.155	26.6
M_4	30.5	36.7	1.180	25.1

Leaf area

The values of total leaf area (LA) taken at 50 per cent flowering was highly influenced by moisture treatments. Treatments receiving higher moistures level (M_1 and M_2) showed higher LA values (Table 1). Sethy et al. (1960) reported that excess moisture conditions caused asphyxiation of roots resulting in more of vegetative growth which is an undesired character for higher productivity. Conversely the moisture regime (M3) receiving medium water level, seemed to be optimum, recorded 110.15 sq.cm. as LA values with least value (1030.61 sq.cm.) recorded by M4. Leaf area expansion is known to be sensitive to water deficit (Legg et al., 1979).

Leaf area duration

Leaf area duration (LAD) was greatly affected by the drought stress treatements (Table 1). For the stressed plants, the LAD was 49 and 42 days in the M_3 and M_4 respectively. The differences in LAD, were primarily due to leaf senescence and leaf area. The longer LAD values noted for M3 was due to less leaf senescence. Fisher and Kohn (1966) showed that the yiled under dry land conditions was inversely related to LAD after anthesis which in turn, was related to the plant water deficit. This is true in the present study also especially for the severely stressed plants (M4).

Specific leaf weight

The differences due to moisture treatments were significant for the mean specific leaf weight (SLW). The drought stress resulted in increased mean SLW. M3 and M4 regimes registered higher SLW values (Table 1). Changes in SLW due to drought has previously been reported (Tusk and Hall, 1980). Increases in leaf thickness appeared to be an adaptive mechanism to drought

(Pandey et al 1984)

Grain yield Vs moisture treatments

It is observed that the irrigation water had negative influence with grain yield (Table 1). Amount of water over and above 215 mm was detrimental to the grain yield. Higher yield of 5208 kg per ha. was obtained in the treatment receiving 212 mm of water while the remaining moisture regimes were on par.

Water Use Efficiency (WUE)

Among the moisture treatments, M4 (stressed plants) had the highest WUE (29.7 kg/ha/mm) followed by M3 (24.6 kg/ha/mm) (Table 1)

Harvest Index (HI)

Higher HI value of 0.38 was registered in the M3 (Table 1) regime suggesting that partitioning of dry matter was relatively more in favour of grains. On the other hand, moisture regimes with higher TDMP(M1 and M2) gave low value for HI.

Relationship among various plants water status parameters

Changes in plant water status as measured by canopy temperature (CT). leaf temperature (LT), leaf diffusive resistance (LRD) and transpiration rate (TR) in varied moisture regimes are given in Table .2. The value of CT and LT were always lower in M1 regime than in the dry regime (M4) whereas they were intermediate in M2 and M3. Differences in LDR and TR values due to stress effects could be attributed to variations in stomatal frequency on the leaf surfaces and to the microclimatic influences on the leaves. Among the moisture regimes tested, M4 (dry regime) registered the highest LDR values with decreased TR thereby increasing the WUE values (Table 1). Nevertheless, optimum moisture supply (M3) maintained cooler leaf temperature in view of the moderate LDR and TR values. However, under high soil moisture conditions (M1 and M2), differences in LDR did not occur and consequently similar values of TR and WUE were observed amongst the plants of these treatments.

It is thus concluded that the pearl millet required an optimum level of 212 mm of irrigation water (inclusive of effective rainfall) for maximising the yield. This might be attribtuted to the favourable plant water status and better translocation efficiency (in terms of higher harvest index) for maintaining physiological functions favourable to higher yield. Nevertheless, though the reduction is significant, M3 was followed by the driest regime (M4) receiving 155 mm of water in respect of next increased yield, exhibiting some drought adaptive mechanisms such as better shoot adjustments (moderate leaf area values) with an extensive deeper root system (for extracting available water even from the deeper soil profiles) and increased mean specific leaf weight. Conversely, excess moisture regimes (M1 and M2) resulted in more of vegetative growth which results in considerable reduction in the final economical yield.

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RESIDUAL EFFECT OF PHOSPHORUS SOURCES ON THE AVAILABILITY OF P IN BLACKGRAM

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ABSTRACT

A field experiment was conducted during 1985-86 at Tamil Nadu Agricultural University, Coimbatore with five phosphatic fertilizer sources and three levels to study the residual effect of fertilizers added to the preceeding crops of fingermillet and maize. A residual crop of blackgram was raised in a cropping sequence of fingermillet-maize-blackgram and the results indiciated that the availability of soil P increased significantly with all the five sources viz., single superphosphate, rock phosphate, rock phosphate + single superphosphate, rock phosphate + phosphobacterium and Diammonium phosphate. The higher level (90 kg P_2O_5/ha) resulted in enhanced availability of phosphorus in all the five sources.

Phosphorus is an essential nutrient element directly affecting crop yield. Application of P in the form of fertilizers has, therefore, become a necessity under most conditions for augmenting crop yield. However, fertilizer P is a costly input. This and its relatively poor utilization by individual crops and fixation - immobility phenomena in the soil, are some of the principal factors that warrant an efficient mangement of fertilizer P (Goswami and Mohinder singh. 1976). The quantity of P absorbed by a single crop from the fertilizers have residual effect on the succeeding crop which is often benefitted by the residual P (Talashilkar and Kadrekar, 1979). Keeping these in view, a study was undertaken to find out the residual effect of differenct P sources on blackgram in a cropping sequence of fingermillet, maize and blackgram at Tamil Nadu Agricultural University, Coimbatore.

MATERIALS AND METHODS

A field experiment was carried out during 1985-86 to evaluate different sources of P for a cereal based cropping sequence of fingermillet-maize-blackgram at Tamil Nadu Agricultural University farm, Coimbatore. The experiment was laid out in factorial randomised block design with three replication. The nutrient status of the clay loam soil (typic ustropept) was found to be

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