LIGHT AND WATER USE IN MAIZE (ZEA MAYS) - PIGEONPEA (*CAJANUS CAJANS*) INTERCROP UNDER SEMI-ARID CONDITIONS OF KENYA

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Abstract
Intercropping cereals and legumes is a better way of utilising resources such as light, water and nitrogen. Understanding of how efficiently these resources are utilised in maize-pigeonpea intercrop system is important to achieve higher productivity. A study was conducted at Jomo Kenyatta University of Agriculture and Technology between October 2001 and June 2002 to determine light and water use in maize-pigeonpea intercrop system. The experiment was laid out as a randomized complete block design (RCBD) replicated 4 times. Treatments included two pigeon pea maturity types; two long duration (erect - ICEAP 00053 and semi-erect - ICEAP 00040) and one medium duration (ICEAP 00557) type intercropped with maize (Katumani) or sole crop. Data on canopy light interception and soil water content changes were determined using sunfleck ceptometer and neutron probe respectively. Results showed that maize intercepted more light than pigeonpea early in the season (0-70 DAP) because the former has a fast initial growth rate than the later thereby minimizing competition for light. Similarly there was spatial and temporal variation in water use. In conclusion temporal complimentarily in maize-pigeonpea intercrop reduced competition for light between the two crops hence maize yields were unaffected. Temporal differences in root growth ensured full use of water during the growing season. Similarly, spatial use of water below the ground could be better by a combination of shallow and deep rooting components in an intercrop system.

Introduction
Pigeon pea has a unique place in the cropping systems of the semi arid tropics. Traditionally over 90% of the pigeonpea is grown as a mixed crop or intercrop with cereals, legumes and commercial crops (Ali, 1996). The suitability of pigeonpea for intercropping lies in its initial slow growth, when as an intercrop, a companion crop with a fast initial growth phase completes, most of its growth and development during the lag phase of pigeonpea; thereby minimizing competition for resources (Sheldrake and Narayanan, 1979). Pigeonpea in the intercrop may provide an excellent way of spatial and temporal separation of root and canopy and hence would be advantageous in sharing limited resources such as nitrogen, light and water with the companion crop. A better understanding of complementality of intercropped maize and pigeonpea in terms of light and water use is needed if higher productivity is to be achieved. This study was therefore designed to determine light and water use of long and medium duration pigeonpeas intercropped with maize.

Materials and Methods
The study was conducted at Jomo Kenyatta University of Agriculture and Technology, Thika. The area is located at 1,549 m above sea level and it receives an average annual rainfall of about 768 mm p.a with an average maximum temperatures of 24.1^{O}C and minimum temperature of 13.5^{O}C and evaporation 105 mm p.a. The experiment was laid out as a randomized complete block design with 7 treatments replicated 4 times. Treatments were: three pigeonpea varieties (one medium- ICEAP 00557, and two long duration (semi erect-ICEAP 00040 and erect -ICEAP 00053) either sole or inter-cropped with maize (Katumani Composite).

Fractional solar radiation interception
Radiation interception of photosynthetically active radiation was measured in both the sole crop, and the intercrop using a Sunfleck Ceptometer (SF-80 Decagon, Pullman, Washington). Ten measurements were taken below the canopy by holding the ceptometer perpendicular to the rows throughout the growing period and two measurements above the canopy per plot. The measurements were taken at 11.30 am to 1.30 pm. (local time) after every 14 days.

Soil water content changes
Soil profile water content changes were determined using a neutron probe (Dicot, Abingdon, UK). Aluminium access tubes (120 cm long with an internal diameter 50 mm) sealed at the lower end were installed in auger-bored holes that were slightly smaller than the tubes. Three-access tubes (between maize rows, maize and pigeonpea row and pigeonpeas rows) were installed per plot in the intercrops prior to sowing. Only one access tube per plot was installed in the sole crop treatments. Neutron counts were taken over 16 seconds 20 cm intervals starting at 50 cm depth up to 110-cm after every 14 days. Soil water content changes at the top 30 cm were determined using gravimetric method.

Results and Discussions

Fractional photosynthetically active radiation (PAR) interception

The proportion PAR intercepted by both maize and pigeonpea increased over time and thereafter decreased as the crops matured (Figure 1). Maize and pigeonpea attained maximum light interception at different times; an indication of early rapid vegetative growth of maize compared to slow initial growth habit of pigeonpea, an example of temporal separation in light use in the intercrop system. This is in agreement with Fukai and Trenbath, 1993. Pigeonpea dominated maize more in the second season (after maize harvest) an indication of compensatory growth, which resulted in increased plant height and total dry matter accumulation. The amount of PAR intercepted by the intercropped and sole pigeonpea varied with pigeonpea varieties. Long duration semi erect (LDSE) intercepted more light i.e. 90% at 160 DAP and long duration erect (LDE) 89% at 172 DAP. The medium duration (MD) pigeonpea only intercepted a maximum of 50 % PAR at 130 DAP. Pigeonpea varietal differences in light interception were probably due to differences in LAI and canopy architecture. Long duration semi-erect had a higher K value (0.5) that may have contributed to higher light interception than long duration erect (K value 0.4) and medium duration (K value 0.2).

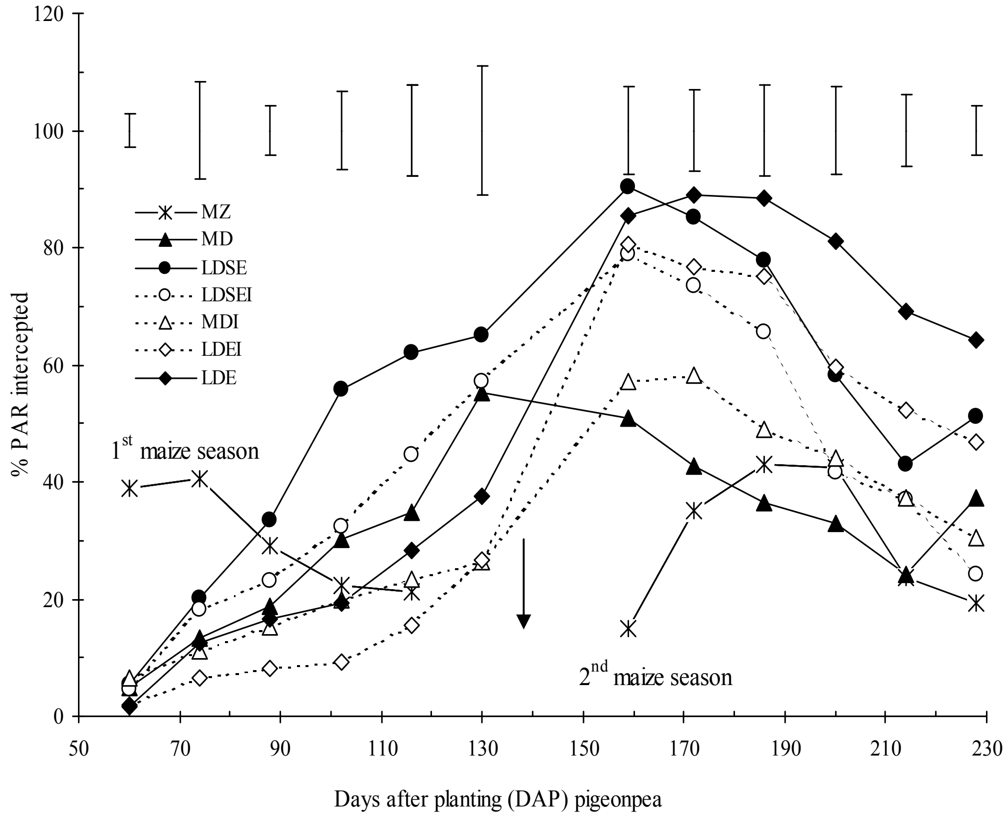

Fig. 1. Fractional PAR light interception by sole crop and intercropped maize and pigeonpeas over time at JKUAT, Thika. MZ = maize, MD = medium duration, LDSE = long duration semi-erect and LDE = long duration erect pigeonpea. MDI, LDSEI and LDEI represent intercrop of medium duration, long duration semi-erect and long duration erect with maize. Bars represent LSD values (P=0.05).

Soil water content changes

Soil moisture content generally decreased over time in the growing season. The changes in profile water content could be attributed to a combination of soil evaporation, transpiration, or crop water uptake. At 59 DAP maize extracted more water than pigeonpeas in sole and intercrop because it was at full vegetative stage and therefore it was at its peak water needs compared to the much smaller pigeonpea canopy (Figure 2). However at the end of the first maize season (116 DAP) soil water content became constant during maturity stage but soil water continued to decline under pigeonpea which was actively growing during that period, an indication of temporal variation in water use. Long duration semi-erect soil water depletion was greater at the depth of 70 - 90 cm later in the season (159 DAP) as compared to the medium duration pigeonpea. This indicated that long duration semi-erect pigeonpea had more roots deeper in the soil profile that were efficient in the extraction of the available soil water than the roots of medium duration. This agrees with Lawn and Troedson (1990). The competition for soil water between the maize and pigeonpea in the intercrop was minimal probably because of differences in crop growth and rooting characteristics; pigeonpea depleted soil water faster by exploring the deeper layers (70 - 90 cm) while maize depleted water at the top layers (30-50 cm depth) hence spatial variation in water use (116 DAP). This is in agreement with Garba and Renard (1991) that an intercrop of legumes with a cereal may use water more efficiently than a monocrop of either species exploring a larger total soil volume for water, especially if the component crops have different rooting patterns.

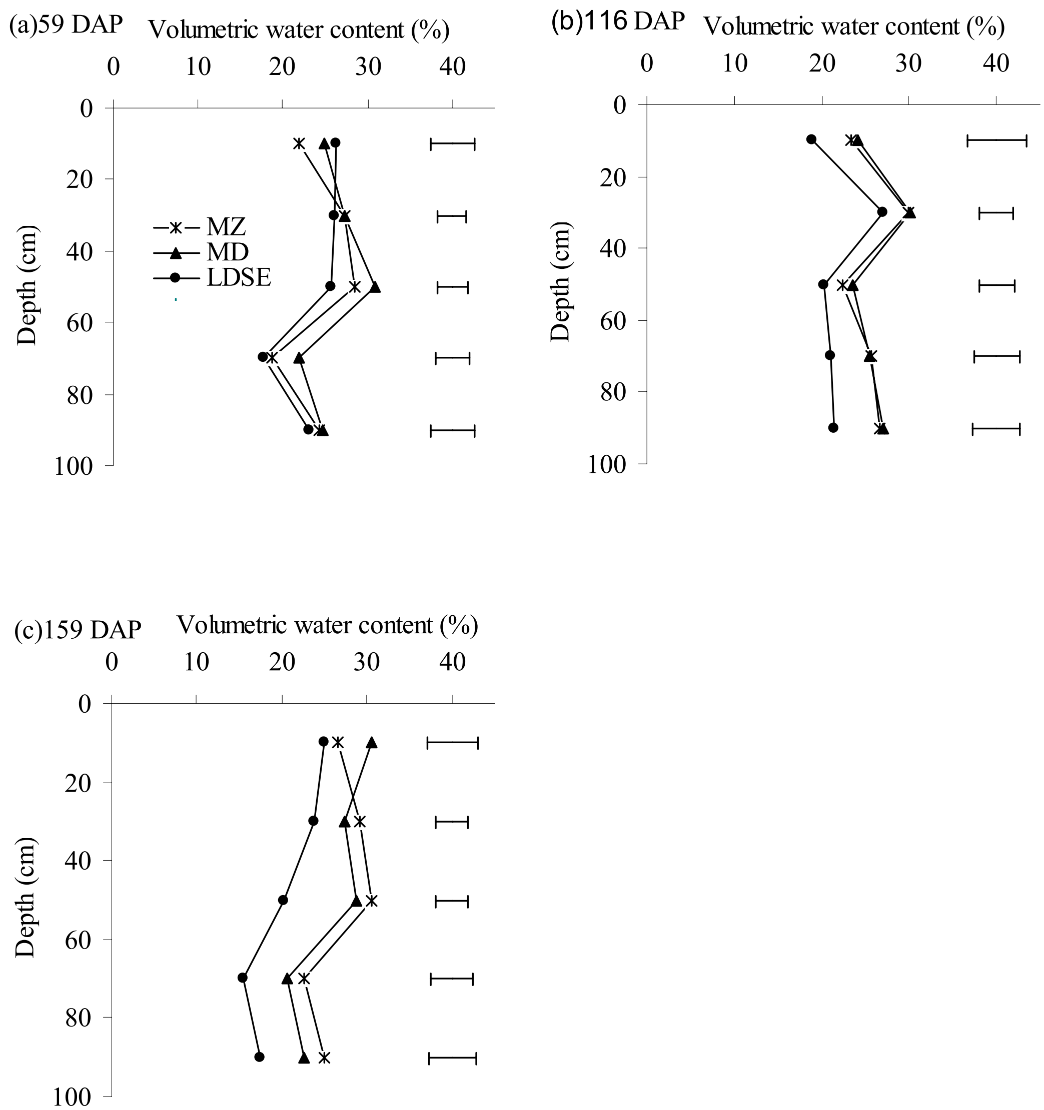

Fig. 2.Volumetric water content (%) of sole and intercropped maize and Pigeonpea over time at JKUAT, Thika. At 59 DAP (maize tasseling stage), 116 DAP (after maize harvest) and 159 DAP (pigeonpea flowering stage). MZ = maize, MD = medium duration and LDSE = long duration semi-erect. Bars represent LSD values (P=0.05).

Conclusions and recommendations

There was temporal separation in light interception by maize and pigeonpea in the intercrop due to slow early pigeonpea growth but rapid maize growth resulting in little competition between the 2 crops and hence maize yields were unaffected. Maize and pigeonpea intercrop also showed complimentarity in water use through spatial separation due to differences in rooting characteristics (maize has shallow roots while pigeonpea is a deep rooted crop) and temporal separation due to differences in growth rates of the crops. In semi-arid areas intercropping maize and pigeonpea is a better way of utilizing available resources like light and water without affecting the yields.

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