Kasetsart J. (Nat.Sci.) 18:117-121 (1984)

Comparative Water Uses of Maize-Mungbean Intercrop, Sole Maize and Sole Mungbean

Amnat Suwanarit[1], Visoot Verasan[1], Chairerk Suwannarat[1] and Surapol Chaochong[2]

ABSTRACT

A field experiment was conducted on a Reddish Brown Lateritic (or Paleustult) soil to compare water uses of maize-mungbean intercrop, sole maize, and sole mungbean with the same plant spacing and density for each crop. Moisture content of the soil was determined with a neutron moisture meter.

The amounts of water lost by evapotranspiration of the three cropping systems were found essentially comparable, though sole maize tended to give the highest values and sole mungbean tended to give the lowest. Circumstances where water lost by evapotranspiration of the intercrop system may be more than that of the sole crops have been discussed.

INTRODUCTION

In maize-based intercropping sytems where maize yield is considered to be of primary crop, populations and spacings of the maize are usually arranged in such a way that maize yield is comparable or close to that of sole maize stand. Juthanon *et al.* (1972), in studying sole maize, found that plant spacings of 100 cm between rows and 25 cm between plants gave grain yield comparable to that of the recommended spacing, i.e., 75 cm between rows and 25 cm between plants. Accordingly, effects of intercropping grain legumes, grown in one or two rows between rows of maize grown with 100 cm interrow spacing, on maize have been investigated (Suwanarit *et al.* 1974, 1975, 1976, 1977, 1979a; Senanarong *et al.* 1979; Thongpae *et al.* 1977). Some of these authors reported decrease in yields of the maize when intercropped with legumes (Suwanarit *et al.* 1974, 1976, 1977, 1979a; and Senanarong *et al.* 1979) while others obtained either no substantial decreases or increases (Suwanarit, *et al.* 1975, 1979b). Thongpae *et al.* (1977) deduced from results of their experiments that this disagreement arose from either one or more of three factors, namely, (1) soil moisture supply, (2) N_2-fixing activities of the legume and (3) phosphate supply in the soil.

This paper presents results of an investigation on water uses of maize-mungbean intercrop, sole maize and sole mungbean.

MATERIALS AND METHODS

A field experiment which has been fully described elsewhere (Suwanarit *et al.* 1983) was conducted from April 5 to July 9, 1981 at the National Corn and Sorghum Research Center, Pakchong, Nakornrajasima province, Thailand. The soil is of Pakchong series, Reddish Brown Lateritic Great Group (Paleustult of the USDA classification) and has available moisture capacity of 9.4% for the ploughed layer and 8.6% for the upper B-horizon.

The experiment comprised of three cropping systems, namely, maize-mungbean intercrop, sole maize, and sole mungbean. In the maize mungbean intercropping system, maize and mungbean were grown in 1 : 1 alternate rows ratio with 100 cm interrow and 75 cm interplant spacings for maize and 100 cm interrow and 12.5

1 Department of Soil Sciences. Faculty of Agriculture. Kasetsart University.

2 The National Corn and Sorghum Research Center.

cm interplant spacings for mungbean; each mungbean row thus being 50 cm from maize rows. Both plants were sown on the same day on soil ridges with 10-15 cm height. In the sole maize and sole mungbean systems, the plants were grown with the same row and plant spacings as those of the corresponding plants in the intercrop system.

One aluminum tube for neutron probe was inserted into the soil at the center of each yield subplot of 3 replicates. Soil moisture content by 30 cm depth increment to 120 cm depth was determined either every 7 days or every fortnight using a neutron moisture meter (Trohel 2651). In the case of irrigation, moisture intake was measured within 24 hours after the irrigation.

The experiment was essentially rain-fed. Supplemental irrigation was made with sprinklers when the plants began to show sign of wilting.

The amount of evapotranspiration, i.e., amount of water lost from soil by evaporation and by transpiration of each treatment during each period, was calculated by graphical method proposed by Verasan (1980) basing on the known equation;

$$hw = \frac{\bar{\theta}V}{100} \cdot Z$$

Where hw = the total amount of soil moisture (in depth unit)

$\bar{\theta}V$ = weighted mean of soil moisture content of soil profile (graphically interpretted by area bound by soil moisture profile smooth curve)

Z = depth of soil profile

Assuming that both deep drainage from the 120 cm profile and upward movement of soil moisture across 120 cm depth were zero, the amount of evapotranspiration as well as the amount of water being irrigated were calculated by the following.

$$\triangle hw = \frac{\triangle \bar{\theta}V}{100} \cdot Z$$

where $\triangle$ hw = the amount of evapotranspiration during the period or the amount of water being irrigated

$\triangle \bar{\theta}V$ = change in weighted mean of soil moisture content of soil profile

In the case that there were rain and irrigation during the period, the amount of evapotranspiration was taken as the sum of $\triangle$hw, the amount of rain water and the amount of irrigation water.

The foregoing assumption is likely to be valid in this case, for the water table is known to be below 24-meter depth and neither rain nor irrigation during the period was excessive.

RESULTS AND DISCUSSION

Plant yields have been reported elsewhere (Suwanarit *et at.* 1983). There were no significant differences in both grain and stover yields of maize in the three cropping systems; mean grain yield being 3,460 kg/ha and mean stover yield being 3,715 kg/ha. Grain and stover yields of mungbean for the intercropping system were only one-third or less of those for the sole mungbean; mean grain yields being 59 kg/ha for the intercrop mungbean and 198 kg/ha for the sole plant while mean stover yields being 187 kg/ha for the intercrop mungbean and 641 for the sole plant. The legume yields were very low due partly to severe infestation by leaf hopper *(Empoasca sp.)* before flowering and presumably due partly to low legume density. Suwanarit *et al.* (1979a), for example, intercropped two rows of mungbean, with 5 cm interplant spacing, between two adjacent maize rows and obtained 322 kg/ha grain for the intercrop legume and 532 kg/ha for the sole mungbean.

Amounts of water from each rain and irrigation and cumulative amounts of water received by the experimental plots are shown in Table 1. Cumulative amounts of water received and of water lost by evapotranspiration at different plant ages of the three cropping systems are shown in Figure 1. At the final moisture measurement (85 days after sowing), the cumulative amount of water received by the plots was 386.2 mm whereas the cummulative amount of water lost by evapotranspiration were in the range of 350-370 mm. These data and cumulative amounts of water recieved at different plant ages shown in

Table 1 Dates on which the experimental plots received rains and irrigation. average amounts of water received from each rain and irrigation and cumulative amounts of water received.

Date	Amount of water (mm)		
	Rain	Irrigation	Cumulative
April, 1981			
4	—	40.0	40.0
12	23.9	—	63.9
13	2.2	—	66.1
14	20.6	—	86.7
16	4.8	—	91.5
17	10.8	—	102.3
18	2.2	—	104.5
19	0.2	—	104.7
21	2.4	—	107.1
27	2.4	—	109.9
29	—	28.6	138.4
May, 1981			
3	10.8	—	149.3
4	26.0	—	175.3
6	0.6	—	175.9
9	4.4	—	180.3
10	1.0	—	181.3
14	—	40.0	221.3
18	18.2	—	239.5
19	18.0	—	257.5
20	14.0	—	271.5
22	2.8	—	274.3
23	12.2	—	286.5
24	1.1	—	287.6
27	12.4	—	300.0
31	1.2	—	301.2
June, 1981			
4	2.2	—	303.4
6	6.2	—	309.6
7	0.6	—	310.2
8	0.2	—	310.4
11	4.2	—	314.6
14	2.2	—	316.8
15	38.6	—	355.4
16	16.6	—	372.0
19	6.8	—	378.8
20	2.4	—	381.2
21	2.2	—	383.4
22	2.0	—	385.4
24	0.4	—	385.8
25	0.4	—	386.2
July, 1981			
2	16.4	—	402.6

Figure 1 confirm that neither appreciable deep drainage nor appreciable upward movement of water through the 120 cm depth occurred during the investigation, and thus the assumption made in the calculation of evapotranspiration is valid.

There were no significant differences in cumulative evapotranspiration of the three cropping systems, though the sole corn tended to give the highest values and the sole mungbean tended to give the lowest, especially at mid-growing season. The differences between the highest and the lowest values of the total amounts of water lost by evapotranspiration was only about 10% of the total.

This result suggests that rate of water evaporation from the soil was so high that additional loss of water through transpiration of the intercrop legume was comparable to or a little less than the decrease in evaporation loss resulted from surface shading by the legume canopy. This is undoubtedly due, at least partly, to frequent rain (Table 1) and, as a result, the soil surface was kept moist most of the time, a condition favouring evaporation from the soil. However in some circumstances, such as when rainfalls are less in number but each is heavy one, where the soil surface is kept dry for a longer period between each rain, it may be expected that evaporation from the soil is greatly reduced. In such circumstances the intercrop legume may increase the total evapotranspiration.

Another factor that may be expected to determine the comparative loss of water by evapotranspiration is population of the intercrop legume. An increase in population of the legume may be expected to result in an increase in the total transpiration and a decrease in the evaporation, and accordingly, at a certain level of the legume population, the increase in transpiration is larger than the decrease in evaporation, a circumstance where the intercrop legume increases the total evapotranspiration.

Further work is undoubtedly nescessary for verifying the foregoing hypotheses.

ACKNOWLEDGEMENTS

This work was undertaken as a part of the

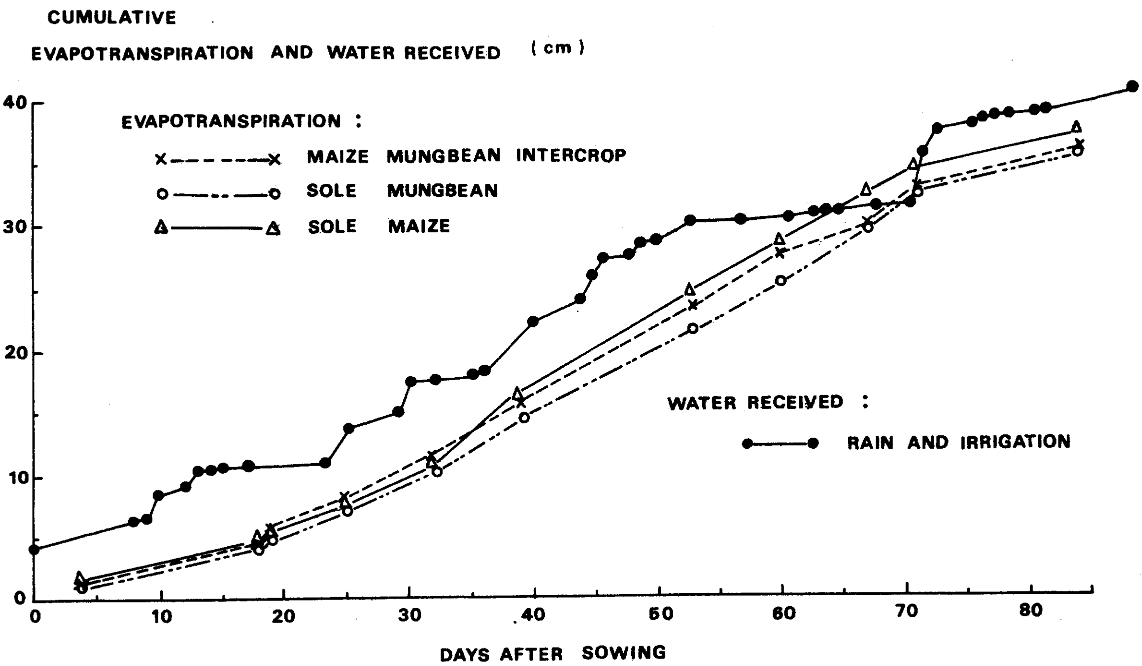

Figure 1 Mean cumulative evapotranspiration of sole maize, sole mungbean, and maize-mungbean intercrop and cumulative water received. Values for the intercrop were means of 8 fertilizer Treat ments, and those for the sole crops were from 1 Treatment; all Treatments being from 3 replicates. The differences in cumulative evapotranspiration at each plant age were not significant at the .05 level.

Coordinated Programme on Nuclear Techniques in the Development of Fertilizer and Water Management Practices for Multiple Cropping supported, technically and financially, by the International Atomic Energy Agency - Food and Agriculture Organization of the United Nations. The neutron soil moisture meter used was borrowed from the Kasetsart University's Highland Agriculture Project. The authors express their sincere gratitudes to the aforegoing organizations.

LITERATURE CITED

Juthanon, O., R. Thiraporn, S. Pleumpunya and S. Campiranon. 1972. A comparison of corn yield grown under wide row and conventional row spacing, pp. 99-101. *In* Thailand National Corn and Sorghum Program 1972 Annual Report, Kasetsart Univ. and Dep. Agr., Bangkok.

Senanarong, N., J. Sarakul, N. Eamsupasit, T. Tungpremsri, S. Thaiwesna, C. Patamadilok, S. Panichkul, R. Chaiṣorn, D. Jaicharcon, P. Swangsri and V. Benjasil. 1979. Research on cultural practices in corn and corn based system, pp. 278-284. *In* Thailand National Corn and Sorghum Program 1979 Annual Report, Dep. Agr., Dep. Agr. Ext., Kasetsart Univ. and the Rockefeller Foundation, Bangkok.

Suwanarit, A., C. Suwannarat, V. Impithuksa, J. Chanchareonsook, T. Na Nakara, P. Wiwatwonwana, S. Thongpae, A. Pohchan and S. Vacharotayan. 1974. Studies on the effects of the intercropping legumes on corn, pp. 161-167. *In* Thailand National Corn and Sorghum Program 1974 Annual Report, Kasetsart. Univ. and Dep. Agr., Bangkok.

Suwanarit, A., C. Suwannarat, V. Impithuksa, J. Chanchareonsook, T. Na Nakara, P Wiwatwonwana, S. Thongpae, A. Pohchan and S. Vacharotayan. 1975. Studies on effects of intercropping legumes on corn, pp. 225-261. *In* Thailand National Corn and Sorghum Program 1975 Annual Report, Kasetsart Univ. and Dep. Agr., Bangkok.

Suwanarit, A., A. Sukthamrong, T. Na Nakara, J. Chanchareonsook, P. Wiwatwonwana, S. Dithipen, L. Powpaichit, P. Malai and S. Vacharotayan. 1976. Effect of intercropping legumes and corn-legume rotation on corn, pp. 229-232. *In* Thailand National Corn and Sorghum Program 1976 Annual Report, Kasetsart Univ. and Dep. Agr., Bangkok.

Suwanarit, A., A. Sukthamrong, J. Chanchareonsook, K. Laosri Chareonsakul, S. Soonthornphat, N. Supakamnerd, L. Pawpaichit and S. Vacharotayan. 1977. A study on effects of intercropping legume-phosphate and intercropping legume-Rhizobium interactions on corn, pp. 117-128. *In* Thailand National Corn and Sorghum Program 1977 Annual Report, Kasetsart Univ. and Dep. Agr., Bangkok.

Suwanarit, A., A. Sukthamrong, P. Rattanaprateep, J. Chanchareonsook, S. Soonthornphat, N. Supakamnerd, S. Dithipen, P. Thongbai, S. Chotchungmaneerat, A. Pohchan and S. Vacharotayan. 1979a. A study on effects of intercropping legume-phosphate and intercropping legume-Rhizobium interactions on corn, pp. 348-357. *In* Thailand National Corn and Sorghum Program 1979 Annual Report, Dep., Agr. Dep. Agr. Ext., Kasetsart Univ. and the Rockefeller Foundation, Bangkok.

Suwanarit, A., A. Sukthamrong, P. Rattanaprateep, J. Chanchareonsook, S. Soonthornphat, N. Supakamnerd, S. Dithipen, P. Thongbai, S. Chotchungmaneerat, A. Pohchan and S. Vacharotayan. 1979 b. Effects of intercropping soy bean, mung bean and peanut on yields and response to nitrogen fertilizer of corn grown on Khorat soil. Ibid. pp. 355-361.

Suwanarit, A., C. Suwannarat and S. Chotchungmaneerat. 1983. Effects of times and methods of N-fertilizer placement on yields and fertilizer utilization of maize-mung bean intercrops as indicated by ^{15}N. Kasetsart J. (Nat. Sci.). 17 (2): 27-33.

Thongpae, S., A. Suwanarit and C. Suwannarat. 1977. Effects of soy bean, mung bean and peanut intercropped to corn on growth, yields and nitrogen reguirement of corn. J. Agric. Sci. 10: 553-567. (in Thai).

Verasan, V. 1980. Soil moisture profile and water use efficiency of mung bean as affected by soil surface managements. J. Soil. Sci. Fertilizer Tech. Forum Thailand 2 (no. 2), pp. 82-103.