

Consumptive Use of Water, Moisture Use Efficiency and Moisture Extraction Pattern in Cotton Intercropping *

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A field experiment constituting three plant rectangularities, three inter-crops and three fertilizer levels was conducted on vertisols, during Kharif season of 1979—80 at Marathwada Agricultural University Research Farm, Parbhani. The results indicated that the consumptive use of water was increased with increase in plant rectangularities. Cotton + groundnut inter cropping system recorded significantly higher consumptive use than Cotton + green gram and Cotton + black gram. The maximum moisture use efficiency i.e. 39.6 and 41.9 kg/ha/cm was recorded by 3.12 plant rectangularity and cotton + green gram inter-cropping system respectively. The moisture extraction pattern was not influenced by the plant rectangularities, intercrops and fertilizer levels at all the layers except at high plant rectangularities more moisture was utilized from deeper layer i.e. 60—90 cm soil depth. Consumptive use of water, moisture use efficiency and moisture extraction pattern were not influenced by fertilizer levels.

Intercropping a unique feature of Indian agriculture, offers a contrast to the monoculture by adapting mixture of legumes with non legume crops. The practice is most common under rainfed conditions and is said to be the only successful method of raising crops in water scarcity areas (Hedge, 1964). The importance of intercropping and its economic advantages are becoming increasingly known but the information on the consumptive use of water, soil moisture extraction pattern and water use efficiency is limited.

Hence the experiment was conducted with the object to find out the effect of plant rectangularities,

intercrops and fertilizer levels on consumptive use of water, water use efficiency and moisture extraction pattern in cotton.

MATERIAL AND METHODS

A field experiment on cotton (Var. G. Cot. 10) was conducted during the kharif season of 1979—80. The soils of experimental plot was clayey in texture. Physico-chemical properties of soil and rainfall data are presented in Table I and Table II, respectively.

Twenty seven treatment combinations of three plant rectangularities, three intercrops and three fertilizer levels were tested in 3³ partially

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confounded design with two replications, treatment details were:

F₃ 100% recommended dose of cotton to cotton + 25% recommended dose of intercrop to intercrop.

TABLE I Physico-chemical properties of soil

| Properties | |
|---------------------------------|--------|
| Coarse sand % | 7.32 |
| Fine sand % | 16.35 |
| Silt % | 20.46 |
| Clay % | 55.20 |
| Texture | clayey |
| pH | 8.30 |
| 1/3 bar moisture % | 35.47 |
| 15 bar moisture % | 17.80 |
| Bulk density g cm ⁻³ | 1.26 |

Plant rectangularities :

| | |
|----------------|----------------------|
| S ₁ | 2.00 (60 cm × 30 cm) |
| S ₂ | 3.12 (75 cm × 24 cm) |
| S ₃ | 4.50 (90 cm × 20 cm) |

Intercrops :

| | |
|----------------|---------------------------|
| I ₁ | Green gram (Var. PS-16) |
| I ₂ | Black gram (Var. T-9) |
| I ₃ | Groundnut (Var. S. B. XI) |

Fertilizer levels :

| | |
|----------------|---|
| F ₁ | 100% recommended dose of cotton to cotton |
| F ₂ | 75% recommended dose of cotton to cotton + 25% recommended dose of intercrop to intercrop |

The recommended fertilizer dose of cotton (50 kg N, 25 kg P₂O₅ and 25 kg K₂O/ha) and intercrops (25 kg N, 50 kg P₂O₅ and 25 kg K₂O/ha) was applied through ammonium sulphate, single super phosphate and muriate of potash. One row each of green gram, black gram and groundnut were intercropped between the rows of cotton. The plant to plant spacing for intercrop was 15, 12 and 10 cm in S₁, S₂ and S₃, respectively.

To study the fluctuations in soil moisture content, soil samples were collected in aluminium moisture boxes from 0-15, 15-30, 30-60 and 60-90 cm depths with the help of soil auger. The soil moisture percentage was determined by gravimetric method and expressed on volumetric basis. The amount of water in the soil at a depth of 0-90 cm was derived by the formula given by Marlett and Binkowski (1961). With the help of this data consumptive use of water and moisture extraction pattern was computed. The water use efficiency (WUE) was determined by the following formula.

$$WUE = \frac{\text{Economic yield kg/ha}}{\text{Consumptive use (cm)}}$$

RESULTS AND DISCUSSION

Consumptive use of water : Consumptive use of water was significantly

influenced by plant rectangularities (Table III). The S_2 and S_3 treatments were at par and utilized significantly more moisture as compared to S_1 treatment (Low plant rectangularity). This may be due to the early deep penetration of the roots of close growing plants in wide rows and extract more moisture from deeper soils layer as compared to narrow rows i. e. low plant rectangularity, when moisture becomes limited in field. (Table II). These results are in confirmative with the findings of Dungan *et al.* (1958). Brown and Shrader (1959) and Willey and Heath (1969).

TABLE II Rainfall and evaporation during 1979-80

| Month | Rainfall (mm) | No. of rainy days | Evaporation (mm) |
|-----------|---------------|-------------------|------------------|
| June | 134.5 | 9 | 5.5 |
| July | 374.2 | 13 | 5.5 |
| August | 208.4 | 16 | 5.7 |
| September | 143.8 | 14 | 5.4 |
| October | 11.2 | 3 | 5.3 |
| November | 18.2 | 6 | 4.5 |
| December | 1.8 | 1 | 4.0 |
| Total | 892.1 | 62 | — |

The cotton intercropped with groundnut utilized significantly more

moisture as compared to cotton + green gram and cotton + black gram which were on par. This was probably due to longer duration of intercrop of groundnut as compared to black and green gram intercrops. The consumptive use of water was not influenced significantly due to fertilizer levels.

Moisture use efficiency : Highest moisture use efficiency i. e. 39.6 kg/cm was recorded when plant rectangularity was 3.12 (75 cm \times 24 cm). This was due to better yield of both the crops (Table III) which ultimately increased the water use efficiency. The cotton intercropped with groundnut recorded moisture use efficiency i. e. 30.1 kg/cm as compared to cotton + green gram (41.9 kg/cm) and cotton + black gram (39.3 kg/cm). This may be due to the competition among cotton and groundnut for moisture space and nutrients for longer duration which resulted poor yield of both the crops and reduced the moisture use efficiency. The 100 per cent recommended fertilizer dose of cotton + 25 per cent recommended fertilizer dose of intercrop increased the moisture use efficiency as compared to other treatments. This was due to more quantity of fertilizers (NPK) application to cotton and intercrop which would have increased the moisture use efficiency.

Moisture extraction pattern : Percentage moisture extraction pattern was not influenced due to plant rectangularities, intercrops and fertilizer levels

in all the soil layers except at high plant rectangularities (3.12 and 4.50) more moisture was utilized from deeper layer i. e. 60-90 cm soil depth (Table IV). This might be due to deep penetration of roots of close growing plants in wider rows and extract more moisture from deeper layers. Similar findings

TABLE IV Moisture extraction pattern (per cent) as influenced by different plant rectangularities, intercrops and fertilizer levels.

| Treat- ments | Soil layers (cm) | | | |
|-----------------|------------------|-------|-------|-------|
| | 0-15 | 15-30 | 30-60 | 60-90 |
| S ₁ | 38.07 | 23.56 | 27.47 | 10.90 |
| S ₂ | 36.60 | 22.02 | 27.62 | 13.76 |
| S ₃ | 36.98 | 22.81 | 25.96 | 14.25 |
| I ₁ | 37.37 | 22.88 | 27.66 | 12.06 |
| I ₂ | 37.36 | 22.09 | 27.96 | 12.59 |
| I ₃ | 36.89 | 23.34 | 27.60 | 12.17 |
| F ₁ | 37.53 | 22.59 | 27.75 | 12.13 |
| F ₂ | 36.88 | 22.64 | 27.74 | 12.74 |
| F ₃ | 37.20 | 23.12 | 27.76 | 11.92 |
| Mean | 37.21 | 22.78 | 27.75 | 12.26 |

were also reported by Willey and Heath (1969).

The results indicated that cotton plus green gram intercropping system recorded the highest moisture use efficiency (41.9 kg/ha/cm) followed by cotton + black gram intercropping system. The plant rectangularity 3.12 (75 cm × 24 cm) was most suitable for cotton intercropping system under dry farming condition in this tract.

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TABLE III Moisture use efficiency in cotton intercropping system.

| Treatments | Seed cotton yield Q/ha | Intercrop yield Q/ha | | | Seed cotton equivalent yield Q/ha | Consumptive use (cm) | Moisture use efficiency (seed cotton equivalent yield kg/cm) |
|----------------|------------------------|----------------------|------------|-----------|-----------------------------------|----------------------|--|
| | | Green gram | Black gram | Groundnut | | | |
| S ₁ | 11.67 | 5.58 | 6.51 | 4.55 | 15.84 | 43.5 | 36.4 |
| S ₂ | 14.14 | 4.82 | 6.17 | 3.65 | 18.35 | 46.3 | 39.6 |
| S ₃ | 12.58 | 4.34 | 5.09 | 3.75 | 15.98 | 45.6 | 35.0 |
| SE \pm | 0.73 | — | — | — | 0.85 | 0.40 | — |
| CD at 5% | 2.16 | — | — | — | N.S. | 1.17 | — |
| I ₁ | 14.58 | 4.91 | — | — | 18.68 | 44.5 | 41.9 |
| I ₂ | 13.50 | — | 5.93 | — | 17.61 | 44.8 | 39.3 |
| I ₃ | 10.86 | — | — | 3.99 | 13.87 | 46.1 | 30.1 |
| SE \pm | 0.73 | — | — | — | 0.85 | 0.40 | — |
| CD at 5% | 2.16 | — | — | — | 2.49 | 1.17 | — |
| F ₁ | 12.63 | 4.03 | 4.87 | 3.01 | 15.61 | 44.7 | 34.9 |
| F ₂ | 12.93 | 5.11 | 5.54 | 4.33 | 16.68 | 45.9 | 36.3 |
| F ₃ | 13.38 | 5.61 | 7.37 | 4.63 | 17.88 | 44.8 | 39.8 |
| SE \pm | 0.73 | — | — | — | 0.85 | 0.40 | — |
| CD at 5% | N.S. | — | — | — | N.S. | N.S. | — |
| SE \pm (SI) | 1.27 | — | — | — | 1.47 | 0.69 | — |
| CD at 5% | N.S. | — | — | — | N.S. | N.S. | — |
| SE \pm (IF) | 1.27 | — | — | — | 1.47 | 0.69 | — |
| CD at 5% | N.S. | — | — | — | N.S. | N.S. | — |
| SE \pm (SF) | 1.27 | — | — | — | 1.47 | 0.69 | — |
| CD at 5% | N.S. | — | — | — | N.S. | N.S. | — |
| SE \pm (SIF) | 2.21 | — | — | — | 2.55 | 1.20 | — |
| Mean | 12.98 | — | — | — | 16.72 | 45.1 | 37.1 |

Note: Prices considered for calculation of seed cotton equivalent yield were: seed cotton Rs. 370, green gram Rs. 310, Black gram Rs. 250 and groundnut Rs. 280.