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OPTIMIZING IRRIGATION REQUIREMENTS FOR MAXIMIZING YIELD OF MOONG BEANS-AN EXPERIMENTAL STUDY

Buland Akthar, Amjed Hussain, Azraful Haq Ahmad, Muhammad Saleem, Naeem Mahmood, Muhammad Aslam" & Khurshid AW

Research Officers Directorate of
Crop Production and Water Management
"Depanment of Agricultural Economics
University of Agriculture, Faisalabad.

The study found that th« irrigation requirement for moong was relatively very low. Application of irrigation water more than that of the optimum depth. [5.0 cm splitted into two intervals, 2.5 cm each at the stages (i) At thirty days after germination, (ii) At flowering stage, yielded 1194 kg per hectare) was not only the wastages of water but yield was also reduced due to more vegetative growth, delay in flowering and shattering of pods.

INTRODUCTION

In Pakistan, minor crops like chillies, potatoes, onion, garlic, moong, mash and masoor occupy around 2.0% of the total cropped area of 21.89 million hectares. Pulses such as gram, moong, mash, masoor, peas, other kharif and other rabbi occupy 1496.4 thousand hectares, out of which 9.61% comes under moong (Anonymous, 1992). Moong, as a pulse, is grown both in the irrigated and the rainfed areas. During 1992-93, this crop was badly affected by rain, cold stress/frost. Consequently, the production of moong fell short by 5.5% to 48.2 million tones as compared with 51.0 million tones produced during 1991-92 (Anonymous 1993). Pulses are important source of nutrients and provide supplementary protein, and vitamins, particularly to the diets based on cereals or starchy foods in almost all the developing countries of the world including Pakistan. The production of moong has remained static since the past decade. As a result, the gap between supply and demand has been widening. In order to bridge this gap, efforts need to be made to increase the overall production of pulses in the country. Province wise share of area, production and average yield of moong is detailed in Table 1.

The Table 1 reveals that the province of Punjab has been playing a leading role in so far as area under moong cultivation and production is concerned. On the other hand, however, it is disturbing to note that the average yield per hectare is the lowest in the Punjab province, being only 378 kg/ha (Anonymous, 1991).

Table 1. Province wise area, Production and yield of Moong-Percent.

Particulars	Punjab	Sindh	NWFP	Balochistan	Pakistan
Area (%)	83.10	6.61	6.05	4.24	100
Production (%)	79.30	6.84	7.72	6.14	100
Yield Kg/ha	378	410	512	575	396

Moong generally requires only two to three irrigations and some times it requires even no irrigation till harvest. Therefore, it is mostly sown on marginal lands by the farmers. But since it commands a prominent position among the pulses, it warrants special attention of both researchers and policy makers. A study on determining the irrigation water requirements for maximizing moong yield was thus planned and conducted in the experimental area at the Post Graduate Agricultural Research Station, University of Agricultural, Faisalabad. The major objective of the study was to find out the effect of different depths of irrigation water on moong production and to work out suitable depth of irrigation for obtaining maximum yield of moong.

MATERIALS AND METHODS

Field experiment was conducted at the Post Graduate Agricultural Research Station (PARS) in RCB design with three replications. Irrigation was applied with the help of cutthroat flume (irrigation water measuring device). Moong was sown during the last week of June. All the doses of nitrogen and Phosphorus were applied at the time of sowing. The plot size was kept to be 7m x21m.

Seed rate was maintained at 20 kg per hectare with row to row and plant to plant distance of 30 cm and 10 cm, respectively. All the other cultural practices were kept similar for all treatments. The data thus generated were analysed with the help of appropriate discrete analysis techniques as prescribed by CIMMYT (1988).

TREATMENTS

A = IRRIGATON FREQUENCIES

TI = No irrigation

T2 = Application of 5 cm depth of irrigation water at the following stages.

a) 2.5 cm at 30 days after germination

b) 2.5 cm at flowering stage.

T3 = Application of 7 cm depth of irrigation water at the following stages.

a) 3.5 cm at 30 days after germination

b) 3.5 cm at flowering stage.

T4 = Application of 9 cm depth of irrigation water at the following stages.

a) 4.5 cm at 30 days after germination.

b) 4.5 cm at flowering stage.

For calculating depth of irrigation, the following formula was applied.

$$QT = 28AD$$

Q = Discharge (lps)

T = Time (hours)

A = Area (hectare)

D = Depth (centimeter)

B. FERTILIZER APPLICATION LEVELS.

a) Nitrogen = 25.0 kg/ha

b) Phosphorus = 62.0 kg/ha

c) Potash = 62.0 kg/ha

RESULTS AND DISCUSSION

Pods per plant: Differences in number of pods per plant were found to be significant among the irrigation treatment. LSD test indicated that maximum number of pods per plant (72) were observed in the Tt treatment, where irrigation water depth was kept at 2.5 cm. Minimum number of pods per plant (39.00) were recorded in T4 treatment where irrigation depth was kept 4.5 cm. Number of pods per plant in TI and T3 treatments were found 41 and 46, respectively.

Table 2. Mean values of the character studied.

Treatments	No. of Pods/Plant	Yield. kg/ha
Tt	41.333 D	839.220 D
T2	72.333 A	1193.820 A
T3	45.667 D	933.780 D
T4	39.000 D	957.420 D
LSD	31.532	135.142

Note: Means sharing common letters do not differ significantly at 5% level of significance

It is evident from these results that with the increase in depth of irrigation water above 2.5 cm, the number of pods per plant reduced. When the depth of irrigation water was increased to 4.5 cm, the number of pods per plant reduced even lower than in T1 treatment where no water was applied at all. These results most nearly conform to the recommendation that water requirements of moong bean arc low. Reduction in number of pods in T3 and T_4 treatment might be due to shedding of flowers at flowering stage on account of excessive irrigation water. This shedding of flowers resulted in lesser pod formation and thus lesser yield in the T3 and T4 treatment as compared to T2 treatment. Singh *et of* (1984), Pahlwan and Hussain (1983) reported substantial differences in number of pods per plant in different genotypes.

YIELD PER HECTARE: Analysis of variance indicated that there was a highly significant difference among treatments for yield per hectare. Maximum yield per hectare (1193.820 kg) was recorded where total depth of irrigation water applied was 5.0 cm splitted into two irrigation of 2.5 cm each (T2)' It was found that the irrigation requirements for moong beans were relatively low. Application of irrigation water more than that of the optimum irrigation depth was not only the wastage but it also tended to reduce the yield. In this experiment, yield per hectare obtained in the irrigation treatment with 3.5 cm and 4.5 cm depths were 933.78 kg and 957.92 kg, respectively and these were statistically at par to each other and in the treatment where no water was applied, the yield was 839.22 kg. In 1987, NM 121-25, produced significantly higher seed yield per hectare (1022 kg). Similarly in 1988, it produced 978 kg per hectare. The genotype of NM 121-25, on account of more number of pods per plant and seeds per pod yielded the highest output in both the years 1987 and 1988 (Ahmad,1989).

It becomes evident from the above that the excess water used in the irrigation treatments T3 and T4 turned out to be just wastage of a precious resource, because extra water thus applied did not contribute towards the final yield, rather it depressed the yield. This reduction of yield may be attributed to more vegetative growth, delay

Table 3. Effect of Irrigation on yield of Moong.

Treatments	Depth of irri. cm	Cost irrig. Rs./ha	Marginal cost Rs./ha	Adjusted yield Kg/ha	Gross Income Rs.jha	Marginal Income
rr	0	0	0	713	5611	5611
1'2	5	120	120	1015.06	7988	2377
1'3	7	168	48	794.00	6249	(-)1739
T4	9	216	48	814.00	6406	(+)157

in flowering, or shattering of pods in case of T3 and T4 treatments.

EFFECT OF IRRIGATION ON YIELD OF MOONG: Generally, it is considered that moong is cultivated on marginal lands and required either no irrigation or only some minimum water. Therefore, for determining the effect of different depths of irrigation on moong yield, an experiment was performed.

Table 4. Partial budget analysis

Particulars	Treatments			
	T1	T2	T3	T4
Observed Av. Yield (kg/ha)	839	1194	934	957
Adjusted Av. Yield (kg/ha)	713	1015	794	814
Gross field benefits (Rs/ha)	5611	7988	6249	6406
Cost that vary				
a) Cash costs (Rs/ha)	-	-	-	-
b) Opportunity cost of water (Rs/ha)	-	120	168	216
Total cost that vary (Rs/ha)	-	120	168	216
Nct ficld benefits (Rs/ha)	5611	7868	6081	6190

Notes: 1) Observed experimental yield was adjusted downward by 15% to reflect farmers level yield obtainable under farm level conditions.

2) Costs that vary in this case constitute only the opportunity cost of water. There were no variable cash costs involved in this experiment.

Table S. Dominance and marginal analysis

Treatment	Total cost that vary (Rs/ha)	Net field benefits (Rs/ha)	Incremental cost (Rs/ha)	Incremental benefits (kg/ha)	Marginal rate of return (%)
T1	-	5611	-	-	-
T2	120	7868	120	2257	1880.83
T3	168	6081 D	-	-	-
T4	216	6190 D	-	-	-

To arrive at the net benefit, marginal cost and marginal income analysis was applied, Table 3 shows that according to marginal cost and marginal income analysis irrigation applied at 5 cm (T2) came out to be the most remunerative depth of water for moong.

DOMINANCE, MARGINAL AND SENSITIVIlY ANALYSIS: Dominance analysis of the data was conducted to eliminate further consideration of all such treatments which yielded uneconomic net benefits. Treatment (TV whit 5 cm depth of irrigation water was the only treatment which gave the highest net benefits promising a marginal rate of return (MRR) of around 1881%. T2 has therefore been recommended to be economically the most feasible practice for procuring maximum

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return from moong cultivation (Table 5).

In order to ascertain the stability of return from this recommended treatment (Tt), the data were further subjected to Sensitivity Analysis and the Minimum Returns Analysis (MRA). Both these analysis suggested that treatment *(T2)* with 5 cm depth of irrigation was to be the most suitable recommendation for farmers adoption even under worst circumstances.

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