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Hari Om
Assistant Professor, Department of Agronomy, Bihar Agricultural University, Sabour, Bihar, India

KS Rana
Principal Scientist, Division of Agronomy, ICAR-IARI New Delhi, India

Md Hashim
Scientist, Regional Station, Samastipur. ICAR-IARI, New Delhi, India

Sanjeev Kumar
Indian Institute of Farming System Research, Modipuram, Meerut, UP, India

Pankaj Kumar
Department of Molecular Biology & Genetic Engineering, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Corresponding Author:
Hari Om
Assistant Professor, Department of Agronomy, Bihar Agricultural University, Sabour, Bihar, India

Effect of moisture and nutrient management on consumptive use, water use efficiency and moisture use rate of greengram in greengram-mustard cropping system

Hari Om, KS Rana, Md Hashim, Sanjeev Kumar and Pankaj Kumar

Abstract
The treatment comprised of four land configurations (Flatbed, flatbed with mulch, ridge-furrow and broadbed-furrow) and three fertility levels (Control, 15 kg N + 30 kg P_2O_5/ha and 15 kg N +30 kg P_2O_5/ha + PSM) in main plot replicated thrice in factorial randomized block design. The water-use efficiency, consumptive use and rate of moisture use were found to the highest with broadbed-furrow followed by in ridge and furrow while lowest with flatbed. The water-use efficiency, consumptive use and rate of moisture were highest with the application of 15 kg N + 30 kg P_2O_5 + PSM and lowest with control.

Keywords: Moisture management, nutrient management water-use efficiency and greengram

Introduction
Indian agriculture depends on the monsoon and small farmers depend on rains to irrigate their fields. Dryland farming is characterized by low crop productivity and high variation in yields from year to year mainly due to uneven rainfall distribution. Moisture stress further affect the nutrient availability to the crop since nutrient mobility depends on optimum soil moisture. The moisture stress can be minimized through *in-situ* moisture conservation, adoption of suitable crops and their varieties (Kumar *et al.*, 2008) [5]. The effective methods of *in-situ* water harvesting are summer ploughing, broadbed-furrows, narrowbed-furrows, ridges-furrows, random tie ridging, compartmental bunding, etc. *Ex-situ* conservation of excess rain water in storage structures like small farm ponds also essential to provide protective/supplemental irrigation for survival of crops in drought prone areas with erratic rainfall.
Efficient use of water and nutrients by improving moisture and nutrient balances, their availability, infiltration and retention in soils by reducing water losses due to evaporation, and improving the quality and availability of ground as well as surface water (Sharma *et al.*, 2005) [7]. Application of foliage mulch @ 5.0 t/ha along with soil conditioner (Jalshakti @ 5.0 kg/ha) prolonged the availability of soil moisture to the crop by increasing infiltration and reducing evaporation from soil (Dhar *et al.*, 2008) [6]. Land configuration based management like ridges-furrows, Furrow irrigated raise bed, broadbed-furrow, bed planting, *etc.* helps in retaining of rain water in soil besides safe removal of run-off in case of excess rainfall helps in increasing crop productivity by 15-30% in dryland as well as rainfed condition (Thakur *et al.*, 2011 [9] and Roy and Singh, 2012 [10]). Water is being the key input for crop production in rainfed and dryland areas, therefore there is need to adopt a comprehensive approach to conserve soil moisture and nutrient under limited moisture condition. There is need to adopt effective moisture management and nutrient management techniques to enhance water use efficiency moisture use rate and consumptive use.

Materials and Methods
The experiment was carried out in *kharif* season 2010 and2011 at research farm Indian Agricultural Research Institute, New Delhi, situated at latitude of 28°38′N, longitude of 77°11′E and altitude of 228.6 m above the mean sea level. The mean annual rainfall of Delhi is 650 mm and more than 80 % generally occurs during the south west monsoon season with mean annual evaporation of 850 mm. The rainfall was good during first year as compared to second year. Thus, establishment of crops, their growth and productivity were better in 2010-11. The soils of experimental field had 145.5 kg/ha alkaline permanganate oxidizable N, 11.8 kg/ha available P and 212 kg 1N ammonium acetate exchangeable K, 0.33 % organic carbon

with 7.6 pH of soil (1:2.5::soil:water). The moisture at 1/3 and 15 atmospheric tensions were 16.61% and 7.63%, respectively with bulk density 1.5 (g/cm^3) of 0-15cm layer.

The treatment comprised of four land configuration (Flatbed, flatbed with mulch, ridge-furrow and broadbed-furrow) and three fertility level (Control, 15 kg N + 30 kg P_2O_5/ha and 15 kg N +30 kg P_2O_5 + PSM (PSB+VAM)/ha) as main plot replicated thrice in factorial Randomized block design. The spacing was 30cm row to row and 10 cm plant to plant. The variety was Pusavishal. Greengram was grown as per recommended package of practices without irrigation

Moisture content in soil was estimated at 25 days interval in rainless periods from three soil depths, viz., 0-30, 30-60 and 60-90 cm commencing from sowing to harvest with the help of soil auger. The fresh soil samples collected from the field were carried to the laboratory in aluminium boxes provided with tight fitting lid. Fresh moist weight was recorded and samples were dried in oven for 48 hours at 105 °C. The loss of moisture was expressed as percentage of oven dry soil. Moisture content in soil was calculated on oven dry weight basis.

$$\text{Soil moisture content (\%)} = \frac{W_1 - W_2}{W_2} \times 100$$

Where, W_1 = weight of moist soil and
W_2 = weight of oven dried soil

$$\text{Moisture content in depth (mm)} = \sum_{i=1}^{n} \frac{\text{Soil moisture content}}{100} \text{ x bdi x di}$$

Where, bdi specific bulk density of ith layer of the soil profile (Mg/m3),
di = depth of ith layer (mm)
n = number of soil layers in the root zone.

The evapotranspiration of each treatment was calculated from the soil moisture used during an interval at beginning and ending of the interval to which the effective rainfall of the period was added. The total consumptive use was then calculated by using of this equation:

$$\text{Seasonal consumptive use (SCU)} = \sum_{i=1}^{n} (bi-ej) + \text{effective rainfall}$$

Where,
bj= Total profile moisture content at the beginning of the jth interval,
ej = Total profile moisture content at the end of the jth interval, and
n = number of time interval

Water-use efficiency of crop was worked out from the seasonal crop consumptive use of water as illustrated by using following formula:

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

Rate of moisture use (mm) was estimated by dividing consumptive use of water by crop duration.

$$\text{Rate of moisture use (mm/day)} = \frac{\text{Consumptive use}}{\text{Crop duration}}$$

Result and Discussion

Result in table 1 showed that the maximum consumptive use of water (234.3 and 248.2 mm) was recorded with broadbed-furrow and closely followed by ridge- furrow, flatbed with mulch and minimum with flatbed (209.3 and 222.9 mm) in first and second year. With the application of 15 kg N+30 kg P_2O_5 + PSM/ha found the highest consumptive use of water (225.6 and 241.4 mm) followed by 15 kg N + 30 kg P_2O_5/ha and minimum with control (216.4 and 228 mm) in first and second year, respectively. The similar result was found by Tetarwal and Rana, 2006 [8], Ahlawat and Gangaiah, 2010[3] and Singh and Rana, 2006 [4]

The highest water-use efficiency recorded in broadbed-furrow (5.1 and 4 kg/ha mm) closely followed by ridge-furrow and flatbed with mulch and lowest in flatbed (3.9 and 3.3 kg/ha mm) in first and second year. The application of 15 kg N+30 kg P_2O_5+PSM/ha recorded maximum water use efficiency (5.1 and 4.3 kg/ha mm) closely followed by 15 kg N+30 kg P_2O_5/ha and minimum in control (3.4 and 2.8 kg/ha mm) in first and second years, respectively. This result conformity with result of Tetarwal and Rana, 2006 [8], Ahlawat and Gangaiah, 2010 [3] and Kantwa, *et al*, 2005 [1]

The highest moisture use rate calculated in broadbed-furrow (2.6 and 2.4 mm/day) closely followed by ridge-furrow and flatbed with mulch and lowest in flatbed (2.3 and 2.1 mm/day) in first and second year. The application of 15 kg N+30 kg P_2O_5+PSM/ha found maximum moisture use rate (2.5 and 2.3 mm/day) closely followed by 15 kg N+30 kg P_2O_5/ha and minimum in control (2.4 and 2.2 mm/day) in both the years. Similar findings reported by Tetarwal and Rana, 2006[8], Ahlawat and Gangaiah, 2010 [3] and Kumar and Rana, 2007 [2]

Conclusion

The water-use efficiency, consumptive use and rate of moisture use were found to the highest with broadbed-furrow followed by in ridge and furrow while lowest with flatbed. The application of 15 kg N + 30 kg P_2O_5 + PSM improve water-use efficiency, consumptive use and rate of moisture use over control.

Table 1: Effect of land configuration and nutrient management on consumptive use, water-use efficiency and rate of moisture use of greengram

Treatment	Consumptive use (mm)		Water-use efficiency (kg/ha-mm)		Rate of moisture use (mm/day)	
	I year	II Year	I year	II Year	I year	II Year
Land configuration						
Flatbed	209.3	222.9	3.9	3.3	2.3	2.1
Flatbed with mulch	216.2	230.2	4.0	3.6	2.4	2.2
Ridge-furrow	228.1	241.4	4.9	3.9	2.5	2.3
Broadbed-furrow	234.3	248.2	5.1	4.0	2.6	2.4
Fertility levels						
Control	216.4	228.0	3.4	2.8	2.4	2.2
15 kg N+30 kg P_2O_5/ha	223.9	237.6	4.8	4.1	2.5	2.3
15 kg N+30 kg P_2O_5/ha +PSM	225.6	241.4	5.1	4.3	2.5	2.3

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