METHODOLOGY AND ENVIRONMENTAL CONDITIONS FOR TESTING EXPEDIENT VIGNA RADIATA VARIETIES IN THE BUKHARA OASIS

Safarova Hilola
Bukhara State Technical University
Bukhara, Uzbekistan

Abstract: This paper outlines the comprehensive environmental profile, soil characteristics, and experimental framework established to evaluate the irrigation regimes of two prominent mung bean (Vigna radiata) varieties "Marjon" and "Durdona" within the arid climate of the Bukhara oasis, Uzbekistan. Conducted between 2021 and 2023 at the "Muhammad-Choriqiy" farm in the Bukhara district, the research tracks soil-moisture variations based on pre-irrigation limits relative to Field Capacity (FC) under standard and alternate-furrow irrigation methods. The experimental baseline confirms that despite extreme thermal stress (up to 45.6 °C) and low soil humus levels (0.8–1.0%), targeted structural water delivery can optimize the vegetative adaptability of fast-maturing leguminous crops.

Keywords: Mung bean, Vigna radiata, Bukhara oasis, irrigation regimes, soil moisture, field capacity.

Introduction

Water scarcity combined with accelerating soil salinization creates severe constraints for agricultural management in the hyper-arid zones of Central Asia, particularly within the Zarafshan River basin. In the Bukhara oasis of Uzbekistan, traditional crop irrigation systems demand vast water consumption, prompting an urgent scientific shift toward water-saving technologies and resilient secondary crops. Mung bean (Vigna radiate L.) serves as an exceptional leguminous option due to its short growth cycle, drought tolerance, and atmospheric nitrogen-fixing capabilities that improve soil structural health. However, maximizing its yield under fluctuating groundwater tables and extreme seasonal heat requires precise quantification of irrigation intervals and method-based field layouts. This study details the structural environment, geographic layout, and comprehensive analytical methodologies designed to test optimized irrigation regimes for distinct mung bean genotypes.

Materials And Method 2.1. Environmental and Hydrogeological Setting The field trials were systematically carried out between 2021 and 2023 at the "Muhammad-Choriqiy" testing ground, geographically situated in the central irrigated belt of the Bukhara district. Geomorphologically, the site is positioned within the subaerial delta of the Zarafshan River, marked by absolute elevations ranging between 180 and 400 meters above sea level.

The regional climate is sharply continental. Meteorological data gathered across the experimental timeframe highlighted intense thermal peaks during July, where maximum ambient temperatures scaled between 42.4 °C and 45.6 °C. Relative humidity drops significantly during the summer peak, bottoming out at 24–30%, while the cumulative humidity deficit ranges from 960 to 1107 mm. Annual precipitation remains critically low, confined strictly to 57.6–214.5 mm, occurring primarily between March and April.

From a hydrogeological standpoint, the primary water source driving the irrigation grid is the Amu-Bukhara machine canal. The regional groundwater matrix is irrigation-alluvial, maintaining a dynamic water table that fluctuates seasonally between depths of 1.5 and 2.5 meters. The average mineralization of these shallow aquifers ranges from 1.5 to 2.0 g/L, spiking up to 3–5 g/L in localized topographic depressions, indicating a highly challenging sulfate-chloride and chloride salinity profile.

2.2. Soil Stratigraphy and Agrochemical Baselines

The topsoil is classified as irrigated meadow-alluvial, varying texturally from medium to light loam. Prior to sowing, chemical profiling confirmed the soil was non-saline to weakly saline. Agrochemical evaluations across the primary tillage zone (0–30 cm) revealed low organic nutrient densities:

Humus Content: 0.8–1.0%

Nutrient Availability: Low to moderate baselines for total nitrogen (N), mobile phosphorus (P_2O_5), and exchangeable potassium (K_2O).

2.3. Experimental Design and Layout

The field trials evaluated two distinct mung bean cultivars registered in the State Catalogue of Uzbekistan

1. "Marjon": A mid-ripening variety featuring a standard 95-day vegetative window.
2. "Durdona": An ultra-early ripening genotype completing its cycle within 70 days.

The experimental plot utilized a split-plot randomized block design incorporating 12 distinct treatments across 4 replicates, creating an operational field matrix spanning a total area of 2.4 hectares. Individual evaluation plots measured exactly 500 m^2 (10×50 m).The structural treatments combined three distinct pre-irrigation soil moisture thresholds set relative to Field Capacity (FC)—specifically 65-65-65% FC, 70-70-65% FC, and 75-75-65% FC—with two standardized furrow delivery modes: Continuous Every-Furrow Irrigation (Control) versus Alternate-Furrow Irrigation. All operational tracks received a uniform macro-nutrient application rate of

$N_{60}P_{80}K_{60}$ kg /ha. Water stream velocities within active furrows were strictly stabilized at 0.15 L/s, with the calculative root-zone tracking layer restricted to depths of 0–50 cm and 0–70 cm.

Table 1. Structural Grid of Experimental Treatments

T/p	Cultivar Genotype	Technical Irrigation Delivery Protocol	Pre-Irrigation Threshold (% FC)
1	Marjon	Every-Furrow Irrigation (Control)	65-65-65
2		Alternate-Furrow Irrigation	
3	Durdona	Every-Furrow Irrigation (Control)	
4		Alternate-Furrow Irrigation	
5	Marjon	Every-Furrow Irrigation (Control)	70-70-65
6		Alternate-Furrow Irrigation	
7	Durdona	Every-Furrow Irrigation (Control)	
8		Alternate-Furrow Irrigation	
9	Marjon	Every-Furrow Irrigation (Control)	75-75-65
10		Alternate-Furrow Irrigation	
11	Durdona	Every-Furrow Irrigation (Control)	
12		Alternate-Furrow Irrigation	

2.4. Analytical and Field Methodologies All physical sampling, soil extractions, and biometric observations strictly conformed to standardized methodologies established by the All-Union CottonResearch Institute (SoyuzNIKhI, 1981) and the Uzbek Scientific Research Institute of Cotton Growing (PSUEAITI, 2007). Soil Physical Properties: Volumetric soil mass and core porosity values were calculated via N.A. Kachinsky's core method using 500 cm^3 metallic cylinders across the 0–50 cm horizon. Infiltration and hydraulic conductivity rates were determined over a 6-hour log interval using concentric ring infiltrometers according to S.I. Dolgov. Active moisture content was continuously quantified through standard gravimetric oven-drying methods.

Hydrometric Monitoring: Water volume distributions entering primary fields were metered using a standard Cippoletti (W-50) weir, while individual furrow discharge velocities were verified using a 90° V-notch Thomson weir. Total net irrigation requirements were calculated mathematically based on S.N. Ryzhov’s moisture-volume equations.

Soil Agrochemical Profiling: Total organic humus was determined using the I.V. Tyurin wet combustion method. Total nitrogen and phosphorus configurations were extracted via I.M. Maltseva and L.P. Gritsenko procedures. Nitrate-nitrogen fractions were colorimetrically mapped using the Grandval-Lajoux technique; mobile phosphorus was analyzed according to B.P. Machigin, and exchangeable potassium via P.V. Protasov’s flame photometry method.

Phenological and Morphological Metrics: Seedling emergence rates, stand densities, plant height increments, lateral branching, and root nodule counts were monitored on the 1st day of every month utilizing 100 fixed indicator plants (25 per replication block). 1000-grain mass and final grain yields were measured directly from the 4 primary harvest rows of each block, adjusted to standard grain moisture content, and scaled to a per-hectare metric.

All numerical data arrays were subjected to statistical analysis of variance to B.A. Dospekhov utilizing standard statistical software.

3 Results

The results of soil moisture determination in the calculated 0–100 cm soil layer, based on the average of three sampling points, are presented below. In the 0–10 cm layer, the average soil moisture content was found to be 22.2%. In the subsequent layers, the values were as follows: 22.1% in the 10–20 cm layer, 21.2% in the 20–30 cm layer, and 21.5% in the 30–40 cm layer. The 40–50 cm layer showed the lowest moisture content among the measured layers, at 20.9%. In the deeper layers, soil moisture was recorded at 21.3% in both the 50–60 cm and 60–70 cm layers, followed by 21.8% in the 70–80 cm layer, 21.9% in the 80–90 cm layer, and 21.8% in the 90–100 cm layer. Overall, the data indicate a relatively uniform distribution of moisture throughout the soil profile, with a slight decrease observed in the middle layers (30–50 cm) and a gradual increase toward the lower layers (70–100 cm). With regard to the seasonal water consumption per unit of yield in repeated mung bean (mash) cultivation, the results obtained in 2023 revealed considerable variation depending on the pre-irrigation soil moisture regime maintained relative to the lower limit of field capacity (LFC). When mung bean varieties were irrigated according to the

65-65-65%, 70-70-65%, and 75-75-65% LFC regimes, the seasonal water consumption per centner of yield ranged from 31.8 to 87.0 m^3/c. This wide range reflects the influence of irrigation regime on water-use efficiency, suggesting that maintaining higher pre-irrigation soil moisture thresholds does not necessarily result in proportionally higher yields, and that water consumption per unit of yield can be optimized through the appropriate selection of irrigation regime.

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