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Effect of Water Use, Water Use Efficiency and Root Development on Barley Based Intercropping System under Rainfed Condition in Central Uttar Pradesh

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ABSTRACT: The field experiment was conducted during rabi season of 2016-17 at Soil Conservation and Water Management Farm of Chandra Shekhar Azad University of Agriculture & Technology, Kanpur to find out suitable row ratio of barley + linseed with different moisture conservation practices tested in intercropping systems under rainfed condition. The results revealed that intercropping system barley + linseed (3:1), proved to be the most promising in production, root development, water use efficiency, net return and benefit cost ratio compared to barley + linseed (4:1) and Barley + Linseed (2:1) under rainfed conditions. Barley equivalent grain yield and maximum net return obtained under moisture conservation practices- Dust mulch created by weeding & hoeing at 25 DAS was found to be more remunerative in comparison to other moisture conservation practices applied under the test.

KEYWORDS: Root development, Net return, water use efficiency, dust mulch.

I. INTRODUCTION

Productivity and profitability of crop can be improved with suitable crop management techniques even by utilizing residual soil moisture under rainfed conditions. Choice of appropriate crops and varieties introducing early to short duration, deep and extensive root system, drought resistance, high yielding and higher water use efficiency parameter is a need of day for profitable farming in moisture stressed regions.

India, which has 18.11 per cent world population about 4 per cent of the world water resources and about 2.4 per cent of world land area. The distribution of world natural resources is highly uneven over space and time in regards to population ratio of the country (Aadhunik Mrida Sanrakshan Evam Jal Prabandh-2017).

Rainfed agriculture plays an important role in contributing to world food security. In India, the area under rainfed agriculture is about 85mha, representing 60 per cent of net cultivated area and supporting 40 per cent share food basket of the country. Soil and water conservation are very important for increasing and sustaining the productivity and monetary returns of crop growth in different agro-ecological regions for their survival on rain water. Efficient utilization of rain water with optimum dose of fertilizer application are essential for sustaining higher yield and monetary returns under rainfed agriculture.

In rainfed area intercropping is an insurance against total failure of crop due to drought or moisture stress conditions. Barley and linseed could be better survival rate under aberrant weather conditions as well as poor fertility status. Soil moisture is the key input in rainfed regions. The crop production is often low due to poor residual moisture



for rabi crop. Water management in intercropping systems are generally recommended for rainfed crop to get stable yield. The total water used in intercropping system is almost same as for sole crop but yield of intercrop increased. The water used efficiency of intercrop is higher than sole crops (Singh *et.al.*, 2018).

Globally, barley (*Hordium Vulgare* L.) ranks 4th among cereal crops, in both yield and acreage after wheat, rice and maize. Barley is grown in area about 70 mha in the world. Global production of barley is 160 mtons. Developing countries account 18% (i.e. 26 m tons) of total barley production and 25% (18.5 m ha) of the total harvested area in the world. In case of barley production in India in term of area and production highest values are recorded by Uttar Pradesh followed by Rajasthan, where as Punjab contributes 21.4 per cent to production from at 13.1 per cent area, while contribute only 8.6 per cent of production from 15 per cent of land area.

Linseed is an important oil seed and fiber crop. It grown for both purposes for its seed and fiber, which is used for manufacturing linen. It is sixth largest oil seed crop in the world. Canada is the largest producer of flaxseed in the world, representing about 40 per cent of world production. China and Russia got 2nd and 3rd ranks on its production and India got 4th rank in the world in linseed productions, these three countries account for 40 per cent of world linseed productions.

In India, Madhya Pradesh, Karnataka, Chhattisgarh, Jharkhand, Bihar, Maharastra, Odisha, Uttar Pradesh, West Bengal and Assam are major Linseed growing states in the country.

II. MATERIALS AND METHODS

A field experiment was conducted during rabi season of 2016-17 at Soil Conservation and Water Management Farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur. The soil of experimental field was typical Gangetic alluvium representing Kanpur type-I in texture of normal fertility status, having organic carbon 0.32%, total nitrogen 0.028%, available P₂O₅ 16.80 kg ha⁻¹, available K₂O 182.10, pH-7.7, electrical conductivity 0.37 dsm⁻¹, water holding capacity 28.77%. Bulk density 1.43 mgm⁻¹, particle density 2.62Mgm⁻¹ and porosity 55.80%.

The field experiment was conducted in Randomized Block Desing with 3 replications, comprising five cropping systems viz., T₁- Barley sole-25cm apart, T₂- Linseed sole- 25cm apart, T₃-Barley + Linseed (2:1), T₄-Barley + Linseed (3:1), T₅-Barley + Linseed (4:1), with 03 moisture conservation practices viz., M₀- Control, M₁- Dust Mulch and M₂- Weeding and hoeing by Khurpi. Crop was sown on 03rd December 2016 and barley crop was harvested on 24.03.2017 and Linseed crop was harvested on 01.04.2017, respectively. During cropping period 42.4mm rainfall was recorded.

Root study was done at harvest by selecting 3 plants from each treatment in only one replication randomly. The roots were washed with a jet of water spray, so that fine rootlets are not broken. Observations were recorded on root depth, No. of roots/plants and Dry weight of roots/plant. Recommended package of practices and fertilizers doses were applied in different treatments.

Soil moisture estimation was done by collecting soil sample with the help of screw auger from a depth of 100cm in a four successive layer's viz., 0-25cm, 25-50cm, 50-75cm and 75-100cm from each treatment in one replication, at different plant growth stages and soil moisture was estimated gravimetrically. After taking fresh weight and oven dry weight of moisture, the per cent of moisture worked out with the help of following formula:

$$M \% = \frac{\text{Fresh wt. of soil} - \text{Oven dry weight of soil.}}{\text{Oven dry weight of soil}} \times 100$$

After getting the consumptive water use, water use efficiency can be calculated with the help of equation given by viets (1962):

$$WUE = Y/ET$$

Where,

WUE = Water use efficiency

Y = Grain/seed yield (kg/ha)

ET = Evapo-transpiration/consumptive use of water

There after values of moisture per cent converted into depth of moistures/water (cm) with the help of following formula:

$$\text{Depth of water (cm)} = \frac{\text{Moisture \%} \times \text{Bulk density} \times \text{Depth}}{100}$$

III. RESULTS AND DISCUSSION

Data pertaining to root development of barley and linseed presented in Table-1 showed that the root development was significantly influenced by various treatments over the period of experimentation. Root development in term of root depth (cm), number of primary roots and dry weight of roots (g) was significantly highest under sole barley followed by barley + linseed (3:1) while lowest values recorded under barley + linseed (2:1) treatment under test. Application of moisture conservation also gave significant variation under different treatment, highest value of root depth was noted in control, while number of primary roots/plant and dry weight of roots (g) were recorded under dust mulch, while lowest under control. In case of cropping system of linseed maximum values regarding root depth, number of primary roots/plant and dry weight of roots (g) was recorded in barley + linseed (3:1) row ratio while lowest values in this regards was noted in sole linseed treatment. The value regards in moisture conservation practices maximum root depth was measured in control treatment, while in regards of number of primary roots/plant and dry weight of roots/plant were recorded highest in dust mulch treatment, which is significantly superior over other treatments applied under the test. The values pertaining to water use efficiency and barley equivalent yield were recorded highest in barley + linseed (3:1) row ratio while lowest values in this regards was noted in sole barley. These findings in accordance with findings of Singh and Rana (2017). In case of moisture conservation practices highest values in regards to water use efficiency and barley equivalent yield were recorded in dust mulch while minimum values of these parameters were noted in control treatment during the test.

As regards to net return of various treatments combinations data presented in Table-3 showed that treatment combination T_4M_1 (Barley + Linseed 3:1) was given highest net return of Rs.33000/ha while minimum values (Rs.17459/ha) of net return was noted under T_1M_0 (Sole barley with control) treatment combination during the test.

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Table-1: Effect of cropping system and moisture conservation practices on root development, water use, water use efficiency and yield of barley.

Treatments	Root depth (cm)	No. of primary roots/plants	Dry Weight of roots (g)	Total water use (mm)	Water use efficiency (kg grain/ha)	Grain yield (q/ha)	Barley equivalent yield (q/ha)
Cropping systems							
Sole Barley	25.4	13.9	1.63	344	7.0	23.97	23.97
Sole Linseed	-	-	-	382	7.3	-	27.92
Barley+Linseed (2:1)	22.5	13.1	1.56	386	7.4	17.14	26.96
Barley+Linseed (3:1)	24.8	13.6	1.61	380	7.9	20.16	29.20
Barley+Linseed (4:1)	23.6	13.4	1.59	355	7.6	20.97	28.52
Moisture Conservation practices							
Control	27.3	13.7	1.62	365	5.8	18.36	21.08
Dust mulch	24.8	14.3	1.66	377	8.7	22.33	32.78
Weeding & hoeing	26.1	14.1	1.64	360	7.8	20.99	28.08



Table-2: Effect of cropping system and moisture conservation practices on root development, water use, water use efficiency and yield of linseed.

Treatments	Root depth (cm)	No. of primary roots/plants	Dry Weight of roots (g)	Total water use (mm)	Water use efficiency (kg grain/ ha)	Grain yield (q/ha)	
Cropping system							
Sole Barley	-	-	-	344	7.0	-	23.97
Sole Linseed	55.7	7.3	1.87	382	7.3	7.78	27.92
Barley + Linseed (2:1)	56.1	7.6	1.89	386	7.4	3.17	26.96
Barley + Linseed (3:1)	57.2	8.0	1.95	370	7.9	2.52	29.20
Barley + Linseed (4:1)	56.6	7.8	1.92	355	7.6	2.20	28.52
Moisture Conservation practices							
Control	60.4	7.4	1.90	365	5.8	2.23	21.08
Dust mulch	50.3	8.8	2.05	377	8.7	5.43	32.78
Weeding & hoeing	55.8	7.9	1.99	360	7.8	4.10	28.08

Table-3: Cost of cultivation, Gross return, Net return and benefit cost ratio of various treatment combinations:

Treatments	Cost of cultivation (Rs/ha)	Gross Return (Rs.ha)	Net return (Rs./ha)	Cost benefit ratio
T ₁ M ₀	26900	44359	17459	1:1.65
T ₁ M ₁	30925	53959	23034	1:1.75
T ₁ M ₂	30120	50234	20114	1:1.67
T ₂ M ₀	25160	26347	1187	1:1.05
T ₂ M ₁	29185	51036	21851	1:1.75
T ₂ M ₂	28380	41945	13565	1:1.48
T ₃ M ₀	26950	39939	12989	1:1.48
T ₃ M ₁	30975	61623	30648	1:1.99
T ₃ M ₂	30170	52948	22778	1:1.76
T ₄ M ₀	27030	42744	15714	1:1.58
T ₄ M ₁	31055	64055	33000	1:2.06
T ₄ M ₂	30250	56061	25811	1:1.85
T ₅ M ₀	27000	42120	15120	1:1.56
T ₅ M ₁	31025	63515	32490	1:2.04
T ₅ M ₂	30220	55804	25584	1:1.84



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