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YD Charjan
Agriculture Research Station, Dr. PDKV, Akola, Maharashtra, India

RS Wankhade
Agriculture Research Station, Dr. PDKV, Akola, Maharashtra, India

AN Paslawar
Agriculture Research Station, Dr. PDKV, Akola, Maharashtra, India

SM Nage
Agriculture Research Station, Dr. PDKV, Akola, Maharashtra, India

AS Lawhale
Agriculture Research Station, Dr. PDKV, Akola, Maharashtra, India

PN Magare
Agriculture Research Station, Dr. PDKV, Akola, Maharashtra, India

Corresponding Author:
YD Charjan
Agriculture Research Station, Dr. PDKV, Akola, Maharashtra, India

Evaluation of suitable crop for limited irrigated condition under rabi cropping

YD Charjan, RS Wankhade, AN Paslawar, SM Nage, AS Lawhale and PN Magare

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Abstract
Climate change adversely affected agriculture production and become more serious concern for developing country like India water is one of the precious and costly input used in agriculture hence an experiment was conducted at Agriculture Research Station, Achalpur under Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, situated at 21° 18' North latitude and 77° 30' to 77° 35' East longitudes with a subtropical climate. The topography of experimental plot was levelled and the soil was black in colour, fairly deep, well drained clayey in texture, low in available nitrogen and phosphorus, high in available potash. The experiment was designed in split plot design with three replications and three levels of irrigation as main plot treatments i.e. I_1 – No Irrigation, I_2 – One Irrigation (40-45 DAS) and I_3 – Two Irrigation (20-25 and 60-65 DAS) with four cropping treatment as subplot treatment i.e. C_1 – Wheat – Cv. Phule Samadhan, C_2 – Safflower – Cv. SSF – 708, C_3 – Sorghum – Phule Suchitra and C_4 – Gram – Phule Vikram, respectively. Application of two irrigation (20-25 and 60-65 DAS) and chickpea crop recorded highest wheat equivalent grain yield 29.76 and 36.53 q/ha with highest benefit: cost ratio (2.98).

Keywords: Suitable crop, limited irrigated, rabi cropping

Introduction
The farmers have adopted their farming system by experience of generations without proper knowledge of agro-climatic conditions, effective cropping pattern and importance of scheduling of irrigation. It is estimate that agriculture output and yield in lower developing countries may decline by 20 and 15 per cent respectively in the presence of climate change on average (Master *et al*., 2010) [6]. More than 60 per cent of Indias total agricultural areaare rainfed, secondly more than 80 per cent Indian farmers are small and marginal thus having less capacity to cope with climate change impacts (Ranuzzi and Srivastava, 2012) [7]. A third problem is more than 52 per cent population depend on climate sensitive sector like agriculture, forestry and fishry for their livelihood (Sathaye *et al*., 2006) [10]. Another important fact that in India, food demand will increase just double by 2050 due to high growth rate of population and it may increase the consumption for resources such as land, water, capital, labour and other precious natural resources (Ahmead *et al*., 2011) [1]. The climate change is likely to reduce the yields of rice, sorghum and millet crop productivity in 16 major agriculture intensive states of India (Gupta *et al*., 2012) [2]. Kumar (2009) [4] investigated that climate change is result I n9 per cent reduction in agriculture revenues in 13 states of the country. The productivity of wheat, mustard, barley and chickpea has decrease due to rise in northern states of India, namely Punjab, Haryana, Rajasthan and Uttar Pradesh (Kar *et al*., 2008) [3]. In Vidharbha region water is limited, however soil is fertile hence to find out the suitable rabi crop under limited irrigation water availability is essential keeping in view the above facts the experiment is planned with the objective to evaluate suitable crop under limited irrigation condition for rabi season.

Methodology
Experiment was conducted at Agriculture Research Station, Achalpur under Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, situated at 21° 18' North latitude and 77° 30' to 77° 35' East longitudes with a subtropical climate during the year 2021-2022. The topography of experimental plot was levelled and the soil was black in colour, fairly deep, well drained clayey in texture, low in available nitrogen, low in available phosphorus, high in available potash. The experiment was designed in split plot design with three replications and three levels of irrigation as main plot treatments i.e. I_1 – No Irrigation, I_2 – One Irrigation (40-45

DAS) and I_3 – Two Irrigation (20-25 and 60-65 DAS) and four cropping treatment as subplot treatment i.e. C_1 – Wheat – Cv. Phule Samadhan, C_2 – Safflower – Cv. SSF – 708, C_3 – Sorghum – Phule Suchitra and C_4 – Gram – Phule Vikram respectively. The spacing followed for each wheat (22.5 cm) – 16 lines, safflower (45 x 20 cm) – 8 lines, sorghum (45 x 15 cm) – 8 lines and gram (30 X 10 cm) – 12 lines, respectively. Fertilizer was applied as per recommendation. During the year 2021-22, total 968.3 mm rainfall received in 54 rainy days. Monsoon was started during 23rd MW. Rainfall of 95.2 mm was received in 6 rainy days up to 24th MW. During September 2021, rainfall of 261.7 mm was received in 15 days. Total 127.2 mm was received during October 2021 and 7.4 mm rainfall was received during December 2021.

Results and Discussion

Treatment I_3 - Irrigation at at 20-25 and 60-65 DAS is significantly superior over I_1 and I_2 treatment, which recorded highest grain yield/ plant (7.62 g), grain yield (16.86 q/ha) and wheat equivalent yield (29.76 q/ha), except in case of treatment I_2 the recorded grain yield (13.97 q/ha) and wheat equivalent yield (24.61 q/ha) which was at par with treatment I_3. Productivity of gram and sorghum crop negatively affected with irrigated area since the regression coefficients of irrigation area with these crop are negative and statistically significant similar finding reported by Kumar *et al*., (2011) [5]. Treatment C_2 - Safflower crop recorded significantly higher grain yield/ plant (8.04 g), which was at par with treatment C_3 (7.22 g). Treatment C_1 growing of wheat recorded highest grain yield (17.85 q/ha), which was significantly superior over rest of the treatment. Treatment C_4 growing of gram crop recorded highest wheat equivalent grain yield (36.53 q/ha), which was significantly superior over rest of the treatment.

Table 1: Effect of irrigation on grain yield of different rabi crops

Treatments	Grain yield/ Plant (g)	Grain yield (q/ha)	Wheat Equ. Yield (q/ha)
A. Main Plot (Irrigation levels)			
I_1: (No Irrigation)	3.70	7.52	14.89
I_2: (Irrigation at 40-45 DAS)	6.37	13.97	24.61
I_3: (Irrigation at 20-25 and 60-65 DAS)	7.62	16.86	29.76
SE m ±	0.17	0.54	1.06
CD at 5%	1.05	3.28	6.45
B. Sub plot (Crop)			
C_1: Wheat	4.04	17.85	17.85
C_2: Safflower	8.04	8.64	23.31
C_3: Sorghum	7.22	10.49	14.65
C_4: Gram	4.29	14.15	36.53
SE m ±	0.32	0.59	1.23
CD at 5%	0.94	1.74	3.65
Int. Irrigation X Crop			
SE m ±	0.55	1.01	2.13
CD at 5%	1.62	3.01	NS

Interaction Effect

Table 2: Interaction effect of irrigation x crop on grain yield/ plant

Spacing/Topping	C1	C2	C3	C4	Total	Mean
I1	1.82	6.23	3.65	3.10	14.80	3.70
I2	4.58	7.88	8.59	4.44	25.49	6.37
I3	5.73	10.02	9.41	5.32	30.48	7.62
Total	12.13	24.13	21.65	12.86	70.78	5.90
Mean	4.04	8.04	7.22	4.29	23.59	5.90
SE m ±	0.55					
CD at 5%	1.62					

Treatment I_3 - Irrigation at at 20-25 and 60-65 DAS with C_2 - safflower is significantly superior over other treatment combinations (10.02 g) with respect to grain yield/plant. However, it was at par with treatment I_2C_3 (10.02 g) and I_3C_3 (10.02 g).

Table 3: Interaction effect of irrigation x crop on grain yield (q/ha)

Spacing/Topping	C1	C2	C3	C4	Total	Mean
I1	8.02	6.64	5.25	10.19	30.09	7.52
I2	20.22	8.49	12.50	14.66	55.86	13.97
I3	25.31	10.80	13.73	17.59	67.44	16.86
Total	53.55	25.93	31.48	42.44	153.39	12.78
Mean	17.85	8.64	10.49	14.15	51.13	12.78
SE m ±	1.01					
CD at 5%	3.01					

Treatment I_3 - Irrigation at at 20-25 and 60-65 DAS with C_1-wheat is significantly superior over other treatment combinations (25.31 q/ha) with respect to grain yield. Significantly higher sorghum grain equivalent yield was noticed with sunflower followed by chickpea and safflower reported by Santosh *et al*., 2011 [9].

Table 4: Effect of irrigation on economics of different rabi crops

Treatments	Cost C. (Rs)	GMR (Rs)	NMR (Rs)	B:C
A. Main Plot (Irrigation levels)				
I_1: (No Irrigation)	17375	35038	17663	1.01
I_2: (Irrigation at 40-45 DAS)	21386	59939	38553	1.80
I_3: (Irrigation at 20-25 and 60-65 DAS)	24029	72380	48350	2.01
SE m ±	-	2428.7	2115.5	-
CD at 5%	-	14779.5	12873.3	-
B. Sub plot (Crop)				
C_1: Wheat	20825	46956	26130	1.25
C_2: Safflower	19048	46058	27010	1.41
C_3: Sorghum	16192	46372	30180	1.86
C_4: Gram	27654	83756	56101	2.02
SE m ±	-	2826.8	2461.6	-
CD at 5%	-	8399.3	7313.9	-
Int. Irrigation X Crop				
SE m ±	-	4896.2	4263.5	
CD at 5%	-	NS	NS	

Treatment I_3 - Irrigation at at 20-25 and 60-65 DAS is recorded highest gross monetary returns (Rs 72380), net monitory returns (Rs 48350) and benefit: cost ratio (2.01) over I_1 and I_2 treatment. Treatment C_4 – growing of gram crop is recorded highest gross monetary returns (Rs 83756), net monitory returns (Rs 56101) and benefit: cost ratio (2.02) over other treatment. Similar results were noted by Santosh *et al*., 2011 [9] and Reddy and Reddy, 2005.

Application of two irrigation (20-25 and 60-65 DAS) and chickpea crop recorded wheat equivalent grain yield 29.76 and 36.53 q/ha with highest benefit: cost ratio (2.02).

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