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Real time monitoring and management of agricultural drought in major rainfed crops (Soybean)

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Abstract
The present study area is located at All India Co-ordinated Research Project, for Dry Land Agriculture Farm for Soybean crop during kharif season of 2024. Having treatment Management of crops during dry spell (Real time intervention), Dust mulching (Hoeing), Opening of furrow after every 4 row 30 DAS, Application of KNO_3, Protective irrigation using sprinkler irrigation method from farm pond, Control (Flatbed sowing, No real time intervention.

Keywords: Application of KNO_3, flat bed sowing, mid-session dry spell, soybean crop

Introduction
The erratic nature of monsoon rains, coupled with rising temperatures and climate change, has intensified the frequency and duration of dry spells in Maharashtra. This poses a serious challenge to agricultural sustainability, water availability, and rural livelihoods. To mitigate these effects, various adaptation strategies have been implemented, including water conservation techniques, drought-resistant crop varieties, and improved soil moisture management practices. In-situ moisture conservation technologies refer to a set of agricultural practices aimed at retaining and efficiently utilizing soil moisture within the root zone of crops. These techniques are especially crucial in rainfed farming systems, where irregular rainfall and prolonged dry spells can severely impact crop productivity. Maharashtra, with its large semi-arid and drought-prone regions, relies heavily on in-situ moisture conservation methods to enhance soil water retention and improve agricultural resilience. Common techniques include mulching, contour ploughing, compartmental bunding, ridges and furrows, deep ploughing, and organic matter incorporation. These practices help reduce runoff, enhance infiltration, minimize evaporation losses, and improve soil health, ultimately leading to better crop yields and sustainable farming. This study explores various in-situ moisture conservation technologies, their effectiveness in Maharashtra's agro-climatic conditions, and their role in mitigating water stress, improving farm productivity, and ensuring long-term agricultural sustainability.

2. Study Area
The present study area is located at All India Co-ordinated Research Project, for Dryland Agriculture Farm, for Soybean crop during kharif season of 2024. The soil type ranges from medium to deep black with pH of 8.2. Geographically Parbhani is situated at 17° 36' North latitude and 76º 47' East longitudes with an elevation of 406m above mean sea level (Agriculture contingency plan-Parbhani district).
The weather prevailing at Parbhani station is categorized as sub-tropical and semi- arid. The region falls an assured rainfall agroclimatic zone of Maharashtra with average annual precipitation of 892mm mostly received between June to September. Rainfall is uneven, erratic and varies from year to year. This tract receiving more than 80% of the rainfall from south-west monsoon. Vasantarao Naik Marathwada Agricultural University, Parbhani which falls under semi-arid tropics having highest temperature 44 °C during month of May and lowest 11 °C during December. The minimum and maximum relative humidity varies between 25 to 63 and 85 to 96 percent, respectively.

3. Material and Methods

The rainfall data for the year 2024 was collected from Department of Agricultural Meteorology, VNMKV, Parbhani. The data on actual date of onset and withdrawal of monsoon as compared to normal are presented in table.

During 2024, the onset of monsoon was on 11th Jun as against the normal onset of monsoon as on 10th June indicating the timely onset of monsoon and thus the sowing was carried out in the second fortnight of Jun after availability of sufficient moisture for sowing of soybean. During the year 2024, the withdrawal of monsoon was observed on 20th October as against the normal withdrawal of monsoon as on 10th October indicating the timely withdrawal of monsoon this year.

Table 1: Details of Monsoon & Rainfall

Normal onset of monsoon	10th June
Actual onset of monsoon during 2024	11th Jun
Annual mean rainfall (mm)	880.9 mm
Annual rainfall during 2024 (mm)	1020.0 mm
Mean crop seasonal rainfall	802.3 mm
Actual crop seasonal rainfall in 2024	909.1 mm
Normal withdrawal of monsoon	1st October
Actual Date of withdrawal of monsoon during 2024	20th October
Effective rainfall	494.5 mm

Table 2: Occurrence of dry spells during 2024

Dry spell number	Dry spell dates	Duration
1	July 09 to July 15	07 days
2	July 27 to Aug 08	13 days
3	Aug 11 to Aug 19	09 days
4	Sep 07 to Sep 20	14 days

During 2024, the first dry spells was observed from July 09 to July 15 for 07 days showing early season dry spell. The second dry spell of 13 days was observed from July 27 to Aug 08 which has also been considered as mid-season dry spell. The third dry spell of 09 days was observed from Aug 11 to Aug 19, which has been considered as again mid-season dry spell and a terminal dry spell was observed during Sep 07 to Dep 20 i.e. of 14 days.

Table 3: Soybean seed yield, GMR, NMR, BC ratio and RWUE as influenced by various treatments

Treatments		Soybean seed yield Kg/ha	GMR, Rs./ha	Cost of cultivation, Rs/ha	NMR, Rs./ha	BC Ratio	RWUE Kg/mm/ha
T_1	Dust mulching	942	46082	28500	17582	1.61	1.90
	Opening of furrow after every 4 rows 30 DAS	978	47843	29000	18843	1.65	1.98
	Spraying of KNO3	902	44125	28800	15325	1.53	1.82
	Protective irrigation	1285	62862	30500	32362	2.06	2.60
T_2	Control	685	33510	26500	7010	1.26	1.38
	SE ±	52	1140		726	0.11	0.14
	CD at 5%	157	3421		2176	0.34	0.43

As per observation of dry spells during the crop growth period in 2024, the real time interventions like dust mulching, opening of furrow after every 4 rows 30 DAS, KNO3 spraying and protective irrigation from farm pond water was applied using sprinkler irrigation method. Dust mulching was undertaken after 30 days after sowing. During mid-season dry spell, furrows were opened after every 4 rows in soybean. KNO3 spraying was under taken in mid-season dry spell in the month of August. During mid-season dry spell (Aug 11 to Aug 19) the treatment of protective irrigation was administered using farm pond water and sprinkler irrigation method. Data presented in Table indicated that, the highest grain yield was observed under the treatment of protective irrigation followed by under the treatment of opening of furrow every after 4 rows 30 DAS. All the real time interventions resulted in increase in grain yield of soybean as compared to control. The lowest grain yield was observed under control treatment. The GMR, NMR, BC ratio and RWUE was also recorded the similar trend.

Soil Moisture

The observations of soil moisture under various treatments during the month of July, August, September and October were taken and the mean monthly soil moisture data is presented in Table 4. During this year, due to even distribution of rainfall in the crop season, much difference in soil moisture per cent was not observed. However, in the treatment of protective irrigation, the sufficient soil moisture was maintained which reflected in yield enhancement. Similarly, in the treatment of opening of conservation furrow, soil moisture was observed higher than other treatment. Dust mulching also reflected sufficient moisture during crop growth period as compared to control. All the real time intervention reflected higher soil moisture in the tune of 31 to 34 per cent during entire crop growth period as compared to control.

Table 4: Mean Soil moisture at various depths during crop growth period

Treatments		July	August	September	October	Mean
T_1	Dust mulching	32	31	34	26	31
	Opening of furrow after every 4 rows 30 DAS	34	33	36	31	34
	Spraying of KNO3	31	30	31	30	31
	Protective irrigation	34	36	36	34	35
T_2	Control	28	25	25	24	26
	SE +	0.7				
	CD at 5%	2.15				

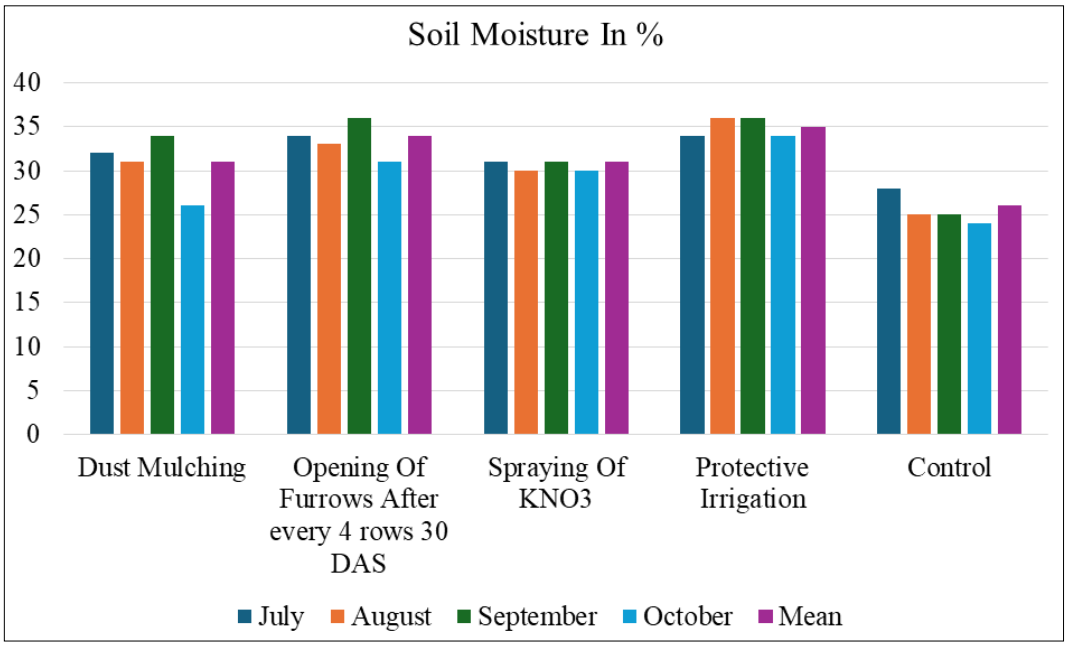

Fig 1: Soil moisture % in various treatment

Conclusion

1. Application of protective irrigation from farm pond was found to be effective in increase in grain yield particularly during dry spells followed by yield increase was observed in the treatment of opening of furrow after every 4 rows 30 DAS.
2. Application of KNO_3 is found to be effective in dry spell management.
3. All the real time interventions resulted in increased soil moisture thus reflected in enhancement of soybean yield as compared to control.
4. The real time inventions i.e. dust mulching and opening of conservation furrow reflected in reducing runoff as compared to control

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