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Yield, economics and available soil moisture as influenced by soil types in different *rabi* crops under rainfed conditions*

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Abstract: A field experiment was carried out during *rabi* 2007-08 at the Regional Agricultural Research Station, Bijapur to find out the influence of soil moisture and soil types on yield and economics of different *rabi* crops. The experiment was laid out in spilt plot design with four replications comprising two main plot treatments as soil types (medium black and deep black) and five sub plot treatments as crops (sorghum, sunflower, chickpea, coriander and safflower). The results showed that, sorghum grain equivalent yield, net returns and BC ratio were significantly higher in sunflower crop (2811 kg/ha, ` 26700/ha and 4.16, respectively) followed by chickpea (1981 kg/ha, ` 17078/ha and 3.18 , respectively). Significantly higher total moisture stored (452.82 mm/0.9 m depth) during the cropping period and consumptive us of water (219.52 mm/0.9 m depth) were noticed in sunflower crop, while significantly higher water use efficiency (8.27 kg/ha-mm) was noticed in sorghum crop.

Key words : Economics, rabi crops, soil types, soil moisture, yield

Introduction

The greater challenge before the country during the 21st century is to produce enough food, fodder, fibre and raw materials for continuously increasing human and animal population. India needs 262 million tones of food grains to feed its 130 million population by 2020 (Paroda, 1999). This has to be achieved within the net cultivated area of 143 m.ha in which 57 m.ha is under irrigated agro-ecosystem and 86 m.ha under rainfed agro-ecosystem. The rainfed agro-ecosystem produces about 45 per cent of the total food grain requirement of India. The above facts emphasize the crucial role played by rainfed agriculture in the Indian economy and food security (Anon., 1997). Majority of the farmers in northern dry zone of Karnataka, cultivate crops either during *kharif* or *rabi* season in a year, but *rabi* season is more assured than the *kharif*. In shallow black soils, pearl millet, foxtail millet, groundnut and pigeon pea are the major crops grown during *kharif*, whereas sorghum, chickpea, sunflower, safflower and coriander are the major crops grown during *rabi* season. The most important constraint for low yields of *rabi* crops is the lack of availability of soil moisture during the post rainy season and hence soil moisture assumes the greatest significance for increasing and stabilizing the production of winter rainfed crops. Rainfall after sowing of *rabi* crops in October-November is a chance factor. Therefore, the soil moisture at sowing largely determines the productivity of winter crops with good weather conditions prevailing thereafter.

Material and methods

A field experiment was conducted during *rabi* season of 2007-08 at Regional Agricultural Research Station, Bijapur. The experiment comprised of two main plots as soil types (medium deep black and deep black) and five sub plots as crops (sorghum, sunflower, chickpea, coriander and safflower). The experiment was laid out in split plot design with four replications. The gross and net plot sizes were 6.0m x 5.4m and 5.4m x 4.5m respectively. The crop of sunflower was sown on 30.8.2007 and the other crops on 24.9.2007. Recommended dose of fertilizers were applied as per package of practices (Anon., 2001) to all the crops at the time of sowing and all the cultural and plant protection measures were adopted as per the state recommendations. Paired 't' test was used for analyzing growth and yield components of individual crops for comparing the effect of two soil types in all the five crops as they differ with respect to physiological and agronomic characters. However, the soil moisture data and other economical parameters were analyzed by using split plot design. The soils of experimental sites were medium deep and deep black soil with a soil pH of 8.1 and 8.6, organic carbon of 0.24 and 0.35 per cent, available nitrogen of 160 and 219 kg/ha, available P_2O_5 of 16 and 22 kg/ha and available K_2O of 308 and 330 kg/ha, respectively. The medium and deep black soils were having a fine sand of 7.1 and 9.1 per cent, silt of 10.8 and 15.0 per cent, clay of 40.5 and 60.0 per cent, permanent wilting point of 14.8 and 16.8 per cent, field capacity of 29.3 and 33.8 per cent and bulk density of 1.46 and 1.33 g/cc, respectively. A total rainfall 318.4 mm was received in 25 rainy days during the cropping period (August to December) as against the normal rainfall of 363.8 mm received in 22 rainy days.

Results and discussion

The performance of different crops showed that, sorghum produced higher grain yield (1619 kg/ha) irrespective of soil types followed by sunflower (1528 kg/ha) and safflower (1233 kg/ha) and lowest was with coriander (306 kg/ha). However, significantly higher sorghum grain equivalent yield (Table 1) was noticed with sunflower (2811 kg/ha) followed by chick pea (1981 kg/ha) and safflower(1973 kg/ha). Sorghum recorded significantly lower sorghum grain equivalent yield (1619 kg/ha) as compared to other crops. Similarly, sunflower recorded higher net returns (` 26700/ha) and benefit cost ratio (4.16). Higher sorghum grain equivalent yield, net returns and BC ratio in sunflower was mainly attributed to higher yield and higher market price of sunflower compared to other crops. Reddy and Reddy (2005) also reported that, sunflower was a profitable crop under rainfed conditions. The soil types did not influence the sorghum

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Table 1. Yield and economics of different *rabi* crops as influenced by soil types

Crops	Crop yield (kg/ha)			Sorghum grain equivalent yield (kg/ha)			Net returns (`/ha)			B:C		
	Medium black soil	Deep black soil	Mean	Medium black soil	Deep black soil	Mean	Medium black soil	Deep black soil	Mean	Medium black soil	Deep black soil	Mean
Sorghum	1723	1514	1619	1723	1514	1619	15622	12282	13952	2.88	2.48	2.68
Sunflower	1548	1508	1528	2849	2774	2811	27169	26231	26700	4.22	4.10	4.16
Chickpea	974	1384	1179	1637	2326	1981	12765	21391	17078	2.63	3.73	3.18
Coriander	286	318	306	1533	1709	1621	10522	12728	11625	2.22	2.47	2.34
Safflower	1081	1385	1233	1730	2217	1973	12510	18594	15552	2.37	3.04	2.71
Mean	-	-		1894	2108		15717	18245		2.86	3.16	
For comparing the means of				S.Em±	C.D.(0.05)		S.Em±	C.D.(0.05)		S.Em±	C.D.(0.05)	
Soil types (S)				158	NS		2003	NS		0.24	NS	
Crops (C)				124	363		1547	4517		0.18	0.54	
Interaction (SxC)			176	513		2189	6389		0.26	0.76		

grain equivalent yield of different crops. While the interaction effect showed that, sunflower in medium black soil recorded significantly higher sorghum grain equivalent yield (2849 kg/ha) as compared to other crops but it was on par with the same crop in deep black soil (2774 kg/ha). Sorghum recorded significantly lower sorghum equivalent yield in deep black soil (1514 kg/ha) compared to other crops. Lower yield of sorghum in deep black soil may be attributed to significantly higher soil moisture content in the soil during the growth period and at 30 DAS in particular which favoured in build up of higher pest incidences *viz.,* aphids and shoot bugs affecting the crop growth adversely compared to medium black soil. Similarly, no yield advantage was observed due to increase in available soil moisture at sowing from 200 mm to 275 mm at Bijapur (Anon., 1989).

The data on total moisture content recorded at sowing in different soil types and crops (Table 2) showed that, significantly higher moisture content was noticed in deep black soil (336.02 mm/0.9 m depth) compared to medium black soil (326.33 mm/0.9 m depth). Among the crops, sorghum showed significantly higher soil moisture content (346.35 mm/0.9 m depth) compared to sunflower (294.48 mm/0.9m depth) but was on par with coriander, safflower and chickpea (342.26, 337.49 and 335.29 mm/0.9 m depth, respectively). The interaction effect showed that, coriander in deep black soil showed significantly higher soil moisture content (350.43 mm/0.9 m depth) and lowest was in sunflower in medium black soil (288.53 mm/0.9 m depth) as compared to other crops.

The total soil moisture content recorded at 30 days after sowing (DAS) showed that, deep black soil recorded significantly higher soil moisture content (340.79 mm/0.9 m depth) than medium black soil (307.35 mm/0.9 m depth). Among the crops, significantly higher moisture content was observed in sorghum (382.48 mm/0/9 m depth) and lowest was with sunflower (182.23 mm/0.9 m depth) as compared to other crops. This shows that, greater soil moisture depletion by sunflower than sorghum in a given time. The interaction effect showed that, sorghum in deep black soil showed significantly higher moisture content (419.02 mm/0.9 m depth) and lowest was in sunflower in medium black soil (172.92 mm/0.9 m depth) compared to other crops.

The total soil moisture content recorded at 60 DAS showed

Table 2. Total soil moisture content (mm/0.9 m depth) at different growth stages of crops as influenced by soil types and crops

Crops	At sowing			30 DAS			60 DAS			At harvest		
	Medium black soil	Deep black soil	Mean	Medium black soil	Deep black soil	Mean	Medium black soil	Deep black soil	Mean	Medium black soil	Deep black soil	Mean
Sorghum	343.08	349.62	346.35	345.94	419.02	342.48	297.45	314.81	306.03	215.52	222.11	218.81
Sunflower	288.53	300.43	294.48	172.92	191.50	182.23	241.34	300.43	270.88	225.25	241.35	233.30
Chickpea	332.66	337.93	335.29	333.03	360.74	346.91	219.91	222.37	221.14	214.88	229.22	222.05
Coriander	334.09	350.43	342.26	338.98	350.68	344.83	205.37	222.60	213.99	221.67	228.66	225.17
Safflower	333.30	341.67	337.49	345.84	381.99	363.91	218.04	230.71	224.37	221.70	230.71	226.21
Mean	326.33	336.02		307.35	340.79		236.38	258.19		219.80	230.41	
For comparing the means of	S.Em±	C.D. (0.05)		S.Em±	C.D. (0.05)		S.Em±	C.D. (0.05)		S.Em±	C.D. (0.05)	
Soil types (S)	0.69	3.12		2.39	10.77		0.39	1.76		1.66	7.46	
Crops (C)	2.48	7.22		2.27	6.63		1.59	4.65		2.23	6.50	
Interaction (SxC)	3.50	10.20		3.21	9.38		2.25	6.57		3.15	9.20	

DAS= Days after sowing

that, deep black soil noticed significantly higher moisture content (258.19 mm/0.9 m depth) compared to medium black soil (236.38 mm/0.9 m depth). Among the crops, sorghum showed significantly higher moisture content (306.03 mm /0.9 m depth) and lowest was with coriander (213.99 mm/0.9 mm depth). The interaction effect showed that, sorghum in deep black soil recorded significantly higher moisture content (314.81 mm/0.9 m depth) and was significantly lowest with coriander in medium black soil (205. 37 mm/0.9 m depth).

The total soil moisture content recorded at harvest showed that, deep black soil showed significantly higher moisture content (230.41 mm/0.9 mm depth) compared to medium black soil (219.80 mm/0.9 mm depth). Among the crops, sunflower showed significantly higher moisture content (233.30 mm/0.9 mm depth) and lowest was with sorghum (218.81 mm/0.9 mm depth). The interaction effect showed that, significantly higher moisture content was noticed with sunflower in deep black soil (241.35 mm/0.9 mm depth) and lowest was with chick pea (214.88 mm/0.9 mm depth).

The total soil moisture stored during the cropping period differed significantly due to soil types (Table 3). Significantly higher total moisture stored was recorded in deep black soil (420.03 mm/0.9 mm depth) compared to medium black soil (408.19 mm/0.9 mm depth). Higher soil moisture in deep black soil may be attributed to higher silt, clay and organic carbon contents than medium black soil. Among the crops, significantly higher total moisture stored was recorded in sunflower (452.82 mm/0.9 mm depth) and lowest with chick pea (398.04 mm/0.9 mm depth) compared to other crops.

Among the crops, sunflower showed significantly higher consumptive use of water (219.52 mm/0.9 mm depth) followed by sorghum (195.32 mm/0.9 mm depth) and lowest was with safflower (174.02 mm/0.9 mm depth). The higher consumptive use of water in sunflower may be attributed to its higher biomass production which demanded extraction of more moisture from its extensive and deep root system compared to other crops. The consumptive use of water was low with coriander and chickpea (174.02 and 176.00 mm, respectively) compared to other crops. This may be attributed to short duration of crops and lower biomass production (Umrani *et al.,* 1981)

Water use efficiency of different crops as influenced by soil types showed that (Table 2), among the crops, significantly higher water use efficiency (WUE) was recorded in sorghum (8.27 kg/ha-mm) followed by safflower (7.10 kg/ha-mm) and lowest was with coriander crop (1.68 kg/ha-mm). The interaction effects revealed that, sorghum in medium black soil showed significantly higher water use efficiency (9.06 kg/ha-mm) followed by safflower and chick pea in deep black soil (8.01 and 8.00 kg/ha-mm, respectively). The results are in conformity with the findings of Patil and Itnal (1983) and Umrani *et al.* (1981). The higher water use efficiency in sorghum may be attributed to its ability to minimize the transpiration losses of water due to the presence of wax on the leaves and by partial rolling of leaves during the day time.

Table 3. Total moisture stored during cropping period, consumptive use of water and water use efficiency of different rabi crops as influenced by soil types

Crops	Total moisture stored (mm/0.9 m)			Consumptive use of water (mm)			Water use efficiency (kg/ha-mm)		
	Medium black soil	Deep black soil	Mean	Medium black soil	Deep black soil	Mean	Medium black soil	Deep black soil	Mean
Sorghum	405.82	422.36	414.09	190.31	200.33	195.32	9.06	7.47	8.27
Sunflower	446.87	458.77	452.82	221.63	217.42	219.52	6.98	6.94	6.96
Chickpea	395.40	400.69	398.04	180.52	171.47	176.00	5.40	8.00	6.70
Coriander	396.83	413.92	405.37	175.16	185.26	180.21	1.63	1.73	1.68
Safflower	396.40	404.41	400.23	174.34	173.70	174.02	6.18	8.01	7.10
Mean	408.19	420.03		188.39	189.63		5.85	6.43	
For comparing	S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.	
the means of		(0.05)			(0.05)			(0.05)	
Soil types (S)	0.56	2.51		1.27	NS		0.39	NS	
Crops (C)	2.31	6.75		3.27	9.55		0.31	0.90	
Interaction (SxC)	3.27	NS		4.63	NS		0.44	1.27	

References

Anonymous, 1989, Annual Report, 1989-90, All India Coordinated Research Project for Dry land Agriculture, Regional Agric. Res. Statn., Bijapur, pp.34-39.

Anonymous, 1997, Annual Report,1997-98, All India Coordinated Research Project for Dry land Agriculture, Bijapur, pp.67-71.

Anonymous, 2001, Package of practices for higher yields for zone -3 of Karnataka. UAS, Dharwad and Dept.of Agriculture, Bangalore.

Paroda, R.L., 1999, Towards Sustainable Agriculture Export, New Paradigma, Nation. Academy of Agric. Sci., In:*Techniques and Management of Field Crops Production.* Ed.P.S.Rathore, p.2.

Patil, V.S. and Itnal, C. J.,1983, Crop production in rainfed black soils of Karnataka. In: *Seminar-cum-Workshop on Dry land Development,* 29-30 October,1983, KSDA and UAS, Bangalore.

Reddy, B.N. and Reddy, G.P., 2005, Economic analysis of sunflower production under rainfed conditions in Kurnol district, Andhra Pradesh. Environ. Ecol.,235 (3): 561-569.

Umrani, N. K., Kale, S. D. and Bhoi, P. G., 1981, Studies on crop planning for drought prone areas of Maharashtra. J. Maharashtra Agric. Univ., 6 (2): 110-113.