USE OF POLYMER HYDROGEL IN SOIL MOISTURE CONSERVATION FOR SUNFLOWER CULTIVATION IN RAINFED SITUATIONS OF NORTHERN KARNATAKA, INDIA: A CASE STUDY

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ABSTRACT

Impacts of climate change on food security are global and local. The agriculture production is being affected by change in mean rainfall and temperature. The inter-annual and inter-seasonal variation in rainfall pattern interms of distribution and quantum are projected change drastically in larger part of drylands in India. Sunflower being a drought tolerant crop, its productivity greatly affected by rainfall. With this background an experiment was mounted in deep black soils at University of Agricultural Sciences, Raichur for two consecutive seasons of kharif 2012 and 2013 in order to identify the appropriate moisture conservation techniques that would help to cope both under high and low rainfall situations. In comparison to first year of experimentation (2012), head diameter (cm), 100 seed weight (g) and seed yield (Kg/ha) recorded incremental change during second year due to more number of rainy days coupled with high rainfall. However, there was no drastic reduction in seed yield of sunflower due to use of agronomically sound moisture conservation techniques. Oil content (%) of sunflower seed was more under stress conditions (2012) than under non-stress conditions (2013) as crop received 469 mm in 2012, to 730 mm rainfall in 2013 between July to October which was most effective period for sunflower. Despite this large variation between rainfall, pooled data indicates that application of hydrogel @ 2.5 kg/ha along with Vermicompost @1 t/ha gave significantly highest sunflower seed yield (1815 kg/ha) as compared to sole application of hydrogel (@ 2.5 kg/ha (1642 kg/ha) or Vermicompost (@1 t/ha (1532 kg/ha) and this is on par with the application of hydrogel @ 2.5 kg/ha along with Gypsum @100 kg/ha (1740 kg/ha) and this was highly correlated with the soil moisture availability at different growth stages. However, the economics shows highest BC ratio was recorded with 2% $CaCl_2$ along with Gouch treatment (4.12) as compared to other treatments. There was strong correlation between head diameter against seed yield (r=0.9), gross returns (r=0.9), net return (r=0.85) and 100 seed weight (0.85). The 100 seed weight had significant correlation with gross and net return. Whereas, seed yield significantly correlated against net return which signifies increase in seed yield of sunflower increases the net profit margin for sunflower farmer.

Key Words: Hydrogel, Moisture Conservation, Sunflower, Yield, Oil percent

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is one of the most important oilseed that originally belonged to subtropical and temperate zones (Demir et. al., 2010) crop and it is widely adaptable and more drought tolerant than most other grain crops (Usman et.al., 1994). It is well adjusted to soil that has high water-holding capacity but is easily adapted to a range of soil conditions (Ahmad et. al.,

1992). Water and nutrients play an important role in sunflower growth and development. It was introduced to India as an oil seed crop during seventies. It gained importance and popularity as a commercial oilseed crop of India under rainfed conditions. This is due to its suitability to many agro ecological regions, short duration, good quality oil and market price. This crop is mainly cultivated in rainy season and post rainy seasons of vertisols but can be grown in any season of the year since this crop is considered as day neutral plant because of its low photoperiod sensitivity. The rainfed sunflower crop witnesses wide fluctuation in productivity due to erratic rainfall distribution and less availability of nutrients. Karnataka is the leading sunflower producing state in the country and contributes nearly 52 per cent of the total area and 40 per cent of the total production in the country.

In India during 1993-94 sunflower occupied an area of 26.7 lakh ha. 13.5 lakh tons production and drastically decreased to 5.5 lakh ha with a production of 4.15 lakh tons during 2014-15 (Anonymous, 2015). Though the crop has gained important place among farmers, the productivity of sunflower is very low. The low productivity is mainly due to the crop growing under rainfed conditions on poor fertility soils with non-availability of cultivars under moisture and nutrient stress situations. To increase production, it is important for decreasing of effects of factors reduced seed yield utilizing from higher production techniques in addition to develop higher yielding cultivars (Kaya et al., 2012 and Skoric, 2012). This crop is often considered as a soil nutrient depleting crop, which puts heavy demands on soil and applied nutrients (Thavaprakash et.al., 2002). Due to its high uptake of nutrients sunflower responds very well to applied nutrients. Application of nutrients increased the seed yield of sunflower by 50 per cent (Chorey and Thosar, 1997). The rainfed sunflower experiences erratic and undependable rainfall, excess and deficient of moisture within the same season. The critical analysis of production factors to increase the productivity of sunflower under different agro ecological situations of India revealed that moisture and nutrient are the key inputs to realize higher and sustainable production of sunflower cultivars under rainfed conditions. The farmers of this region are resource poor and use very little fertilizer. Identification of best agronomic practices suited to moisture and nutrient stress conditions are vital to the farmers of this region. Hence, the hydrogel along with FYM, vermicompost and gypsum were evaluated under the influence of moisture and nutrient management practices in sunflower.

MATERIAL AND METHOD

Water is the most important factor limiting crop productivity at different growth stages of crop growth and development. Water stress is likely the most important factor that adversely affects plant growth and development. In this direction, a field experiment was conducted during the kharif seasons of 2012 and 2013 at Main Agriculture Research Station (MARS), University of Agricultural Sciences, Raichur, Karnataka, India. Geographically the experiment place is located in North Eastern Dry Zone (Zone-2) of Karnataka State, which falls between 16^{o} 15' N latitude and 77^{o} 20' E longitude with an altitude of 389 meters above mean sea level. The soil of the experimental site belongs to medium black with clay loam texture. The soil of the experimental field in both years was sandy clay to clay with pH ranging from 8.0 to 8.7, organic carbon from 0.37 to 0.61%, available phosphorus 3 to 21 kg/ha and available potassium 293-588 kg/ha. The soil has field capacity of 16.6% to 28.2% and permanent wilting point of 7.47% to 13.1% with available water holding capacity of 10.24 to 16.96 cms at 75cm depth. The potential sunflower hybrid, RSFH-130 was used with eight treatments viz., 2% $CaCl_2$ + Gouch treatment, Vermicompost seed line application (1 t/ha), FYM seed line application (2.5 t/ha), Gypsum (100 kg/ha), Hydrogel (2.5 kg/ha) seed line application, Vermicompost (1 t/ha) + Hydrogel (2.5 kg/ha), Gypsum + Hydrogel (2.5 kg/ha) and control was 100 % NPK. The experiment was laid out in completely randomized block design with three replications. The observations were recorded on growth, yield attributes and yield. Economics were computed based on the prevailing market price. The oil

content of sunflower seed was estimated by using Nuclear Magnetic Resonance (NMR) method (Model: Oxford MQA 6005). Finally the results were analyzed with suitable statistical analysis.

RESULTS AND DISCUSSION

Rainfall and Number of Rainy Days during Growth Period

Rainfall between July and October, the most effective rainfall period for sunflower growth varied from 361 mm in 2012, to 565.5 mm in 2013 against the past 30 years average of 730 mm, which were received in 25 and 34 days, respectively. However, entire year recorded hardly 468.9 mm in 31 days during 2012 and 729.9 mm in 48 days during 2013 (Table 1).

Table 1: Rainfall (Mm) And No. Of Rainy Days Observed During Sunflower Growth Period

Sl. No.	Month	2012		2013	
		Rainfall (mm)	No. of Rainy Days	Rainfall (mm)	No. of Rainy Days
1	July	103.6	06	116.4	10
2	August	50.0	03	102.2	06
3	September	126.0	09	250.0	13
4	October	81.4	07	96.9	05
Total		361.0	25	565.5	34
Total (Entire Year)		468.9	31	729.9	48

The data revealed that during rainy seasons of 2012 and 2013, application of hydrogel @ 2.5 kg/ha along with Vermicompost @1 t/ha gave significantly highest head diameter (18.3 cm and 19.9 cm, respectively) as compared to control i.e. 100% RDF (15.6 cm and 17.5 cm, respectively), sole application of hydrogel (@ 2.5 kg/ha (17.8 cm and 19.3 cm, respectively) or Vermicompost (@1 t/ha (16.9 cm and 19.3 cm, respectively) and this is on par with the application of hydrogel @ 2.5 kg/ha along with Gypsum @100 kg/ha (17.7 cm and 19.4 cm, respectively). Similar trend was also observed with 100 seed weight and oil content (Table 2). The results emphasizes that the combined effect of both hydrogel for moisture conservation and vermicompost or gypsum for nutrient supply have gave significantly higher values of, head diameter, oil content and 100 seed weight than the individual effect and as compared to 100% RDF. The moisture conservation effect and rainfall observed during the crop growth indicates that due to hydrogel use, the effect of deficit in rainfall during 2012 is reduced on the growth performance of the crop. The benefits of soil moisture conservation and nutrient supply in sunflower during post rainy season is also reported by Reddy et.al., 2003, Bakery et.al., 2009 and Aravinda Kumar et.al., 2010.

Seed and Oil Content

The two years rainy season pooled data (Table 2) revealed that the seed yield and oil content of sunflower was influenced significantly by integrated moisture conservation and nutrient source. Application of hydrogel @ 2.5 kg/ha along with Vermicompost @1 t/ha resulted in higher seed yield (1815 kg/ha) which was increased to the extent of 29% (1281 kg/ha) and 20% (1452 kg/ha) than 100% RDF (control) and FYM seed line application (2.5 t/ha), respectively. The various

moisture conservation (2% $CaCl_2$ and hydrogel) and nutrient sources (RDF, FYM, vermicompost and gypsum) did not vary much in oil content. However, hydrogel @ 2.5 kg/ha along with Vermicompost @1 t/ha recorded higher oil content (36.8%) than 2% $CaCl_2$ + gouch treatment (36.1%). The oil content values during 2012 are higher than the 2013, this is because of rainfall occurred during flowering in 2013 causes pollen wash thereby reduction in oil content was noticed. Irrespective of the treatments, the seed yields recorded during 2012 are lower as compared to 2013. This is due to the variation in both rainfall amount (361mm and 565mm, respectively) and rainy days (25 and 34 days, respectively). However, between the years the quantity of sunflower yield reduction in 100% RDF (control plot) was higher (15%) than the 3% recorded with 2% $CaCl_2$ + gouch treatment, 5.5% with sole application of hydrogel (2.5 kg/ha) and 8% with hydrogel @ 2.5 kg/ha along with Vermicompost @1 t/ha. This is mainly due to the moisture conservation by both $CaCl_2$ and hydrogel and its utilization by the crop during requirement. Similar results have been observed by Megur et.al., 1993, Devidayal and Agarwal 1998.

The rainfed sunflower is sometimes more hungry than the thirsty which adds to its low productivity. There is strong interaction between nutrient source and moisture availability for crop yield. Application of nutrients facilitates root growth, which can extract soil moisture from deeper layers and moisture conservation practices ensured the better availability of moisture to the plants. Furthermore, supply of nutrients facilitates early development of canopy that covers the soil and intercepts more solar radiation and thereby reduces the evaporation component of the evapotranspiration. The moisture conservation effect and nutrient source for sunflower were found not significant for oil content.

Economics

The individual years and mean of two years data pertaining to the gross returns, cost of cultivation, net returns and B C ratio are given in Table 3. Pooled data reveals that the maximum gross returns of Rs.62586/ha was recorded under hydrogel @ 2.5 kg/ha along with Vermicompost @1 t/ha where as lowest gross returns (Rs.44147/ha) was recorded under control (100% RDF). Among moisture conservation options, maximum gross returns (Rs.56631/ha) was recorded under hydrogel (2.5 kg/ha) as compared to 2% $CaCl_2$ + gouch treatment (Rs.52624/ha). The moisture conservation with nutrient sources significantly recorded higher net returns (Rs.42354/ha) than rest of the treatments, while 100% RDF (control) recorded lowest net returns (Rs.31657/ha). The highest BC ratio was recorded with 2% $CaCl_2$ along with Gouch treatment (4.12) as compared to other treatments. Similar results were observed by Kazen et.al, 2013 and Singh et.al, 2005. The higher gross returns, net returns and B C ratio of moisture conservation and nutrient sources might be due to higher seed yield coupled with higher market price during both the years.

CONCLUSION

The results of two years experiment clearly indicated that adoption of moisture conservation techniques like use of polymer hydrogel and treating seeds with 2% $CaCl_2$ along with Gouch and supply of nutrients through organics like FYM, vermicompost, gypsum to nutrient exhaustive crops like sunflower are proved to be best one in Vertisols of Semi Arid Tropics of Karnataka for obtaining higher yield and monetary returns besides having higher production sustainability of sunflower.

Table 2: Effect af Moisture Conservatıon and Nutrient Source on the Performance of Sunflower Yield and Yield Parameters

Treatment Details	2012				2013				Pooled data			
	Head Diameter (cm)	100 Seed Wt (g)	Oil Content (%)	Seed Yield (kg / ha)	Head Diameter (cm)	100 Seed Wt (g)	Oil Content (%)	Seed Yield (kg / ha)	Head Diameter (cm)	100 Seed Wt (g)	Oil Content (%)	Seed Yield (kg / ha)
Control (100 % NPK)	15.6	2.63	41.1	1175	17.5	3.37	31.7	1387	16.5	3.00	36.4	1281
2% $CaCl_2$ + Gouch treatment	17.4	3.13	39.9	1502	18.2	3.53	32.2	1550	17.8	3.33	36.1	1526
Vermicompost seed line application (1 t/ha)	16.9	3.09	41.1	1389	19.3	3.50	31.5	1674	18.1	3.30	36.3	1532
FYM seed line application (2.5 t/ha)	16.7	3.04	40.9	1315	19.1	3.47	32.6	1589	17.9	3.26	36.7	1452
Gypsum (100 kg/ha)	17.5	3.00	40.4	1366	19.1	3.43	32.8	1555	18.3	3.22	36.6	1461
Hydrogel (2.5 kg/ha) seed line application	17.8	3.03	40.6	1595	19.3	3.53	32.2	1689	18.6	3.28	36.4	1642
Vermicompost (1 t/ha) + Hydrogel (2.5 kg/ha)	18.3	3.14	40.3	1740	19.9	3.57	33.0	1890	19.1	3.36	36.8	1815
Gypsum + Hydrogel (2.5 kg/ha)	17.7	3.05	39.6	1646	19.4	3.57	32.9	1835	18.6	3.31	36.2	1740
SEm $\pm$	0.71	0.21	0.76	99.28	0.65	0.12	0.81	113.31	0.38	0.07	0.61	72.34
CD at 5%	2.16	0.62	2.33	301.12	1.97	0.38	2.44	343.69	1.14	0.23	1.86	219.43
CV %	7.17	11.08	3.28	11.73	5.92	6.17	4.31	11.92	3.60	3.96	2.92	8.05

Table 3: Effect of Moisture Conservation and Nutrient Source on the Performance of Sunflower Economics

Treatment Details	2012				2013				Pooled data			
	Gross Returns (Rs/ha)	Cost of Cultivation (Rs/ha)	Net Returns (Rs/ha)	B C Ratio	Gross Returns (Rs/ha)	Cost of Cultivation (Rs/ha)	Net Returns (Rs/ha)	B C Ratio	Gross Returns (Rs/ha)	Cost of Cultivation (Rs/ha)	Net Returns (Rs/ha)	B C Ratio
Control (100 % NPK)	41137	12265	28872	3.35	47158	12715	34443	3.71	44147	12490	31657	3.53
2% $CaCl_2$ + Gouch treatment	52570	12565	40005	4.18	52683	13015	39668	4.05	52624	12790	39834	4.12
Vermicompost seed line application (1 t/ha)	48603	16265	32338	2.99	56924	16715	40209	3.41	52765	16490	36275	3.20
FYM seed line application (2.5 t/ha)	46037	14765	31272	3.12	54032	15215	38817	3.55	50037	14990	35047	3.33
Gypsum (100 kg/ha)	47810	12915	34895	3.70	52876	13365	39511	3.96	50340	13140	37200	3.83
Hydrogel (2.5 kg/ha) seed line application	55825	16765	39060	3.33	57438	17215	40223	3.34	56631	16990	39641	3.33
Vermicompost (1 t/ha) + Hydrogel (2.5 kg/ha)	60923	20765	40158	2.93	64248	21215	43033	3.03	62586	20990	41596	2.98
Gypsum + Hydrogel (2.5 kg/ha)	57610	17415	40195	3.31	62385	17865	44520	3.49	59994	17640	42354	3.40
SEm $\pm$	3473	--	3473	0.24	3852	--	3852	0.26	2491	--	2491	0.18
CD at 5%	10535	--	10534	0.73	11685	--	11685	0.79	7555	--	7555	0.55
CV %	11.72	--	16.78	12.32	11.92	--	16.66	12.71	8.04	--	11.37	9.13

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