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Original Research Article

Productivity and Economics of Kharif-Sunflower in Response to Organic Manures and Water Retentive Soil Amending Materials under Rainfed Condition

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A B S T R A C T

A field experiment was conducted on Sunflower at Oilseeds Research Unit, Dr. P. D. K. V, Akola. The treatment consisted of T_1: RDF (80:60:30), T_2: RDF + 5t FYM ha^{-1} spreading across field, T_3: RDF + 2.5t FYM ha^{-1} in seed furrows, T_4: RDF + Hydrogel @ 2.5kg ha^{-1} in seed furrows, T_5: RDF + Humic acid @ 2.5 kg ha^{-1} in seed furrows, T_6: RDF + Vermicompost @ 2.5t ha^{-1} in seed furrows and T_7: RDF + Fly ash @ 2.5 t ha^{-1} in seed furrows. The treatments were statistically laid down in randomised block design with three replications. The rainfall received during cropping period was 593.1, 645.0 and 832.3 mm with 32, 28 and 45 rainy days during *Kharif* 2014-15, 2015-16 and 2016-17, respectively. Pooled analysis noted that, application of 100 % RDF + Vermicompost @ 2.5 t ha^{-1} (T6) found to be superior in recording significantly higher seed and oil yield of sunflower which was closely followed by application of 100 % RDF + hydrogel @ 2.5 kg ha^{-1}. Gross monetary returns were found superior with the application of 100 % RDF + Vermicompost @ 2.5 t ha^{-1} which was narrowly followed by application of 100 % RDF + hydrogel @ 2.5 kg ha^{-1}. Whereas, application of 100% RDF + hydrogel @ 2.5 kg ha^{-1} recorded significantly higher net monetary returns. Application of 100% RDF alone registered higher B: C ratio (2.18) followed by application of 100 % RDF + fly ash @ 2.5 t ha^{-1} (2.12). Application of 100 % RDF + Hydrogel @ 2.5 kg ha^{-1} was recorded highest incremental cost benefit ratio (1.81) which was closely followed by application of 100 % RDF + fly ash @ 2.5 t ha^{-1} (1.69).

Keywords

Sunflower, Hydrogel, Organic manures, Yield and economics

Introduction

Sunflower (*Helianthus annuus* L.) is an important oilseed crop and is native to southern parts of USA and Mexico. Sunflower ranks third next only to groundnut and soybean in total production of oilseed of the world. Sunflower crop was introduced to India during 1969 as a supplement to introduce oilseed crops to bridge the gap of recurring edible oil shortage in the country.

The commercial cultivation of sunflower started in India during 1972-73. This crop has been well accepted by the farming community because of its desirable attributes such as short duration, photoperiod insensitivity, adaptability to wide range of soil and climatic conditions, drought tolerance, lower seed rate, higher seed multiplication ratio and high quality of edible oil. In India, sunflower is cultivated over an area of about 5.2 million hectares with a production of 3.35 million tonnes and productivity of 643 kg per hectare (Anon., 2017).

The *Kharif* sunflower experiences erratic and undependable rainfall, moisture excess and deficit, within the same season. Sunflower is resistant to drought but requires continuous availability of soil moisture for optimal performance. Water is an important life saving natural resource for the crop. It profoundly influences photosynthesis, respiration, absorption, translocation and utilization of mineral nutrients and cell division. Due to limited availability of irrigation water in India, it is important to increase irrigation efficiency and water productivity of crop and to exploit the existing water potential by reducing the losses of water and also ensuring better living condition for crop growth. The use of organic manures, fly ash, humic acid and soil amending material like super absorbent polymer has a great potential to exploit the existing water in soil for agricultural crop by increasing their production.

In 2015, The Indian Agriculture Research Institute (IARI) reported the development of a novel hydrogel for agricultural use. It was intended to help farmers to cope with drought, making efficient use of water in arid and semi-arid regions of India. Superabsorbent hydrogel polymers can in principle influence soil permeability, density, structure, texture, evaporation and infiltration rates of water through soils. (L. O., Ekebafe *et.al.* 2011).

Organic manures and vermicompost besides supplying N, P, and K also make unavailable sources of elemental nitrogen, bound phosphates, micronutrients, and decomposed plant residues into an available form to facilitate the plants to absorb the nutrients. Application of organic sources encouraged the growth and activity of mycorrhizae and other beneficial organisms in the soil and is also helpful in alleviating the increasing incidence or deficiency of secondary and micronutrients and is capable of sustaining high crop productivity, soil health and soil physical properties like water holding capacity. (Nambiar K.K.M. *et. al.* 1992)

Fly ash is produced as a result of coal combustion in thermal power station and discharged in ash ponds. Water Holding Capacity (WHC) of fly ash is generally 49-66% on weight basis, while the moisture retention ranges from 6.1% at 15 bar to 13.4% at 1/3 bar (Natusch and Wallace, 1974).

Humic Acid is a long chain molecule, which is high in molecular weight, dark brown and is soluble in an alkali solution. This is the portion of the soil responsible for composting which transfers the nutrient from the soil to the living organism. This material accompanies the nutrient into the organism and performs many benefits.

At the present time, soil scientists and agronomist hold a more holistic view and at least recognize that humus influences soil fertility through its effect on the water-holding capacity of the soil. Also, since plants have been shown to absorb and translocate the complex organic molecules of systemic insecticides, they can no longer discredit the idea that plants may be able to absorb the soluble forms of humus. (Anonymous, 1984).

This encourages taking the comparative study on relative performance of organic manure and water retentive soil amending materials on Kharif-sunflower productivity and its economics to find out the economic feasibility under rainfed condition.

Materials and Methods

During *kharif* 2014-15, 2015-16 and 2016-17, a field experiment was conducted on Sunflower at Oilseeds Research Unit, Dr. P. D. K. V, Akola. The treatment consisted of T_1: RDF (80:60:30), T_2: RDF + 5t FYM ha^{-1} spreading across field, T_3: RDF + 2.5t FYM ha^{-1} in seed furrows, T_4: RDF + Hydrogel @ 2.5kg ha^{-1} in seed furrows, T_5: RDF + Humic acid @ 2.5 kg ha^{-1} in seed furrows, T_6: RDF + Vermicompost @ 2.5t ha^{-1} in seed furrows and T_7: RDF + Fly ash @ 2.5 t ha^{-1} in seed furrows. The treatments were statistically laid down in randomised block design with three replications. The rainfall received during cropping period was 593.1, 645.0 and 832.3 mm with 32, 28 and 45 rainy days during *Kharif* 2014-15, 2015-16 and 2016-17, respectively. Observations were recorded for growth dynamics, yield components and total yield by selecting the representative plants and plots. The oil content of sunflower seed was estimated using the nuclear magnetic resonance (NMR) method (Model Oxford mQA 6005). The economics and incremental cost benefit ratio was calculated on the basis of existing costs of required inputs and prevailing market prices of sunflower.

Effect on seed and oil yield

The three year pooled data on sunflower seed and oil yield (Table 1), revealed that seed yield of Kharif-sunflower was significantly enhanced due to application of different composts and water retentive material over control where only 100 % RDF was applied during 2015-16, 2016-17 and pooled over season. During 2014-15, significantly highest seed yield (713 kg ha^{-1}) was obtained with the application of 100% RDF (80:60:30 kg NPK kg ha^{-1}) alone which was strongly followed by treatment of application of 100% RDF with Vermicompost @ 2.5 t ha^{-1} and 100 % RDF + Hydrogel @ 2.5 kg ha^{-1}.

Significantly highest seed yield was gained with the application of 100% RDF with Vermicompost @ 2.5 t ha^{-1} as compare to other treatments, but it was not found statistically superior to treatment T_4 i.e. application of 100 % RDF + Hydrogel @ 2.5 kg ha^{-1} and T_5 i.e. application of 100 % RDF + humic acid @ 2.5 kg ha^{-1}, during 2nd and 3rd year of study and pooled over season, The application of 100% RDF with Vermicompost @ 2.5 t ha^{-1} produced 31.93, 25.74 and 20.85 % more yield over application of 100 % RDF alone, during 2015-16, 2016-17 and pooled over season, respectively. As oil yield is openly related with seed yield, the same trend was observed in oil yield kg ha^{-1}. An increase in seed yield could be because of sufficient availability of water and indirectly nutrients supplied by organic manures or water retentive material to the plant under water stress condition, which in turn lead to better translocation of water, nutrients and photo assimilates and finally better plant development. These findings are in agreement with the findings of Khatik and Dikshit (2001) and Vedpathak M.M. and B.L. Chavan (2016).

Economics

Economics worked out from the emerged data for three years of study and pooled over season presented in table 2, indicated that during first year of study (2014-15), application of 100 % RDF alone gained significantly highest GMR but found at par with the application of 100% RDF with Vermicompost @ 2.5 t ha^{-1}. Whereas, GMR was found significantly higher with the application of 100% RDF with Vermicompost @ 2.5 t ha^{-1}, during 2015-16, 2016-17 and pooled over season. But it was found at par with application of 100 % RDF + Hydrogel @ 2.5 kg ha^{-1} (T_4) and 100 % RDF + humic acid @ 2.5 kg ha-1 (T_5). The lowest GMR was recorded with 100% RDF alone.

In case of NMR, during 2014-15, significantly higher value was recorded with the application of 100 % RDF over other all treatments. Whereas, during 2015-16, application of 100 % RDF + fly ash @ 2.5 t ha^{-1} recorded significantly highest NMR but it was found at par with treatment T_4 and T_5.

During last year of study (2016-17) and pooled over season, significantly highest NMR was registered with 100 % RDF + hydrogel @ 2.5 kg ha^{-1} and it was found at par with T_5, T_7 and T_1. Application of 100% RDF alone registered higher B: C ratio (2.18) followed by application of 100 % RDF + fly ash @ 2.5 t ha^{-1} (2.12).

Data presented in table 3, noted that application of 100 % RDF + Hydrogel @ 2.5 kg ha^{-1} was recorded highest incremental cost benefit ratio (1.81) which was closely followed by application of 100 % RDF + fly ash @ 2.5 t ha^{-1} (1.69). These types of results might be recorded due to the quantity and unit cost of the inputs utilized in different treatments which ultimately increases the cost of cultivation. These results are in close conformity of the findings of Konthoujam Nandini Devi *et. al*. (2013) in Soybean.

Table.1 Seed and oil Yield of sunflower as influenced by different treatments (Pooled 2014 - 2017)

Treatments	Seed Yield kgha^{-1}				Oil Yield kgha^{-1}			
	14-15	15-16	16-17	Pooled	14-15	15-16	16-17	Pooled
T_1: RDF (80:60:30)	713	971	1713	1132	250	302	713	422
T_2: RDF + 5t FYM ha^{-1}	628	1082	1741	1150	210	335	719	421
T_3: RDF + 2.5t FYM ha^{-1}	614	1141	1775	1176	216	354	736	435
T_4: RDF + HG @ 2.5kg ha^{-1}	643	1241	2096	1326	225	381	883	496
T_5: RDF + HA @ 2.5 kg ha^{-1}	589	1181	1998	1256	209	367	834	470
T_6: RDF + VC @ 2.5t ha^{-1}	670	1281	2154	1368	238	395	890	507
T_7: RDF + FA @ 2.5 t ha^{-1}	632	1205	1832	1223	225	372	756	451
SE (M) ±	**22.29**	**56.97**	**102.5**	**42.28**	**8.55**	**17.96**	**41.2**	**15.45**
CD @5 %	**70.21**	**175.55**	**315.8**	**130.27**	**26.36**	**55.36**	**126.9**	**47.60**
CV %	**8.16**	**8.53**	**9.34**	**9.94**	**9.60**	**8.69**	**9.03**	**9.85**

Table.2 Economics of sunflower as influenced by different treatments (Pooled 2014 - 2017)

Treatments	GMR Rs.ha^{-1}				COC (Rs. ha^{-1})	NMR Rs.ha^{-1}				B:C
	2014 -15	2015 -16	2016 -17	Pooled		2014 -15	2015 -16	2016 -17	Pooled	
T_1: RDF (80:60:30)	21401	32039	51394	34943	16041	5353	15998	35353	18902	2.18
T_2: RDF + 5t FYM ha^{-1}	18839	35719	52239	35597	36041	-17209	-322	16198	-444	0.99

T_3: RDF + 2.5t FYM ha^{-1}	18419	37652	53242	36436	26041	-7628	11611	27201	10395	1.40
T_4: RDF + Hg @ 2.5kg ha^{-1}	19287	40957	62868	41035	20541	-1261	20416	42327	20494	2.00
T_5: RDF + HA @ 2.5 kg ha^{-1}	17660	38961	59949	38854	19041	-1388	19920	40908	19813	2.04
T_6: RDF + VC @ 2.5t ha^{-1}	20092	42266	64608	42320	33541	-13456	8725	31067	8779	1.26
T_7: RDF + FA @ 2.5 t ha^{-1}	18952	39772	54966	37894	17916	1029	21856	37050	19978	2.12
SE (M) ±	**683**	**1880**	**3074**	**1304**	**--**	**684**	**1880**	**3074**	**1793**	**--**
CD @5 %	**2106**	**5793**	**9473**	**4019**	**--**	**2106**	**5793**	**9473**	**5524**	**--**
CV %	**6.16**	**8.53**	**9.34**	**5.92**	**--**	**27.08**	**22.31**	**15.93**	**22.20**	**--**

Table.3 ICBR as influenced by different treatments (Pooled 2014 - 2017)

Treatments	**Pooled Seed Yield (kg ha-1)**	**Increase yield over control (kg ha-1)**	**Additional income over control (Rs. ha-1)**	**Cost of Treatment (Rs. ha-1)**	**ICBR**
T_1: RDF (80:60:30)	1132	-	-	-	-
T_2: RDF + 5t FYM ha^{-1}	1150	18	633	20000	0.03
T_3: RDF + 2.5t FYM ha^{-1}	1176	44	1543	10000	0.15
T_4: RDF + Hg @ 2.5kg ha^{-1}	1326	194	6792	3750	1.81
T_5: RDF + HA @ 2.5 kg ha^{-1}	1256	123	4319	3000	1.44
T_6: RDF + VC @ 2.5t ha^{-1}	1368	236	8245	17500	0.47
T_7: RDF + FA @ 2.5 t ha^{-1}	1223	91	3170	1875	1.69

Fig.1 Seed yield of Sunflower (kg/ha)

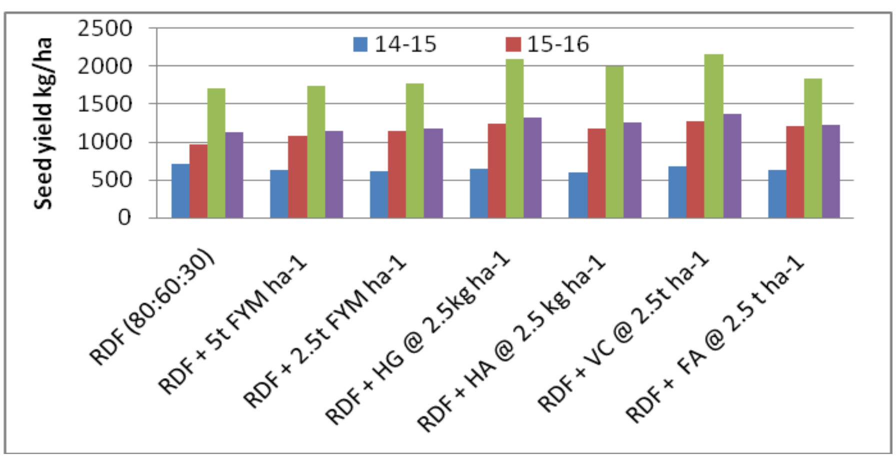
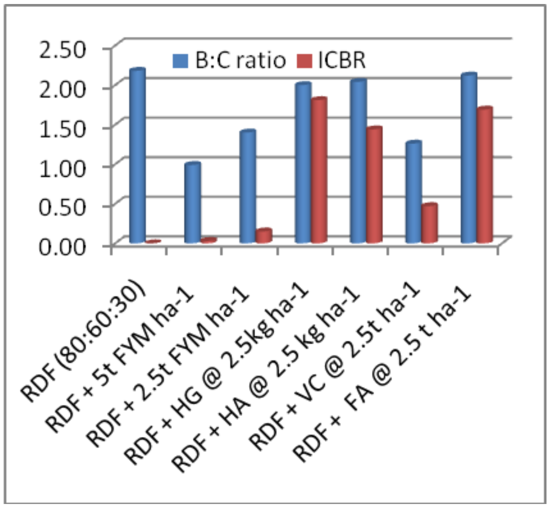


Fig.2 B:C and ICB ratio



Conclusions

Three years data and pooled results indicated that application of 100 % RDF + Vermicompost @ 2.5 t ha^{-1} (T6) found to be superior in recording significantly higher seed and oil yield of sunflower which was closely followed by application of 100 % RDF + hydrogel @ 2.5 kg ha^{-1}. Gross monetary returns were found superior with the application of 100 % RDF + Vermicompost @ 2.5 t ha^{-1} which was narrowly followed by application of 100 % RDF + hydrogel @ 2.5 kg ha^{-1}. Whereas, application of 100% RDF + hydrogel @ 2.5 kg ha^{-1} recorded significantly higher net monetary returns in pooled analysis. Application of 100% RDF alone registered higher B: C ratio (2.18) followed by application of 100 % RDF + fly ash @ 2.5 t ha^{-1} (2.12). Application of 100 % RDF + Hydrogel @ 2.5 kg ha^{-1} was recorded highest incremental cost benefit ratio (1.81) which was closely followed by application of 100 % RDF + fly ash @ 2.5 t ha^{-1} (1.69).

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