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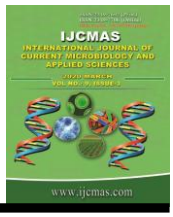

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Economics of Sorghum - Chickpea Cropping System as Affected by Integrated Nutrient Management (INM) under Rainfed Conditions

Seema M. Nemade[1]*, N. B. Mohod[2], G. J. Bhagat[1] , V. R. Thakur[1], D. T. Dhule[1] and M. M. Ganvir[1]

[1]College of Agriculture, Dr P.D.K.V.Akola, India
[2]Department of Agronomy Dr.P.D.K.V.,Akola, India

**Corresponding author*

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A B S T R A C T

A field experiment on Integrated Nutrient Management in sorghum-chickpea cropping system was conducted to identify an ideal integration of organic and inorganic nutrient sources for getting maximum yield and monetary benefit with minimum input cost. The experiment on sequence of kharif sorghum and rabi chickpea was conducted during kharif season of 2013-2015 at the farm of Sorghum Research Unit(CRS) Dr.PDKV,Akola The experiment was conducted in RBD with the nine nutrient management treatments in *Kharif* for sorghum which were T1-100% RDN through inorganic fertilizer,T2-50% RDN through inorganic fertilizer+50% RDN through FYM ,T3-75% RDN through inorganic fertilizer+25% RDN through FYM ,T4-50% RDN through inorganic fertilizer + 50% RDN through vermicompost ,N5:75% RDN through inorganic fertilizer + 25% RDN through vermicompost,T6-50% RDN through inorganic fertilizer+25% RDN through FYM+25% RDN through vermicompost,T7-75% RDN through inorganic fertilizer + 25% RDN through FYM+ seed treatment with microbial fertilizers PSB+ Azospirillum, T8-75% RDN through inorganic fertilizer+25% RDN through vermicompost+ seed treatment with microbial fertilizers PSB+ Azospirillum,T9-75% RDN through inorganic fertilizer + seed treatment with microbial fertilizers PSB+Azospirillum. Whereas chickpea was gown on the same randomization without application of fertilizers in *rabi*. The integration of organic and inorganic fertilizers were superior to inorganic treatments alone for both crops in sequence. Application of 75% RDN through inorganic fertilizer+ 25% RDN through FYM + seed treatment with PSB + Azospirillum to *kharif* sorghum and growing *rabi* chickpea without recommended dose of fertilizer recorded higher economic returns and B:C ratio of sole crop as well as system. This might be as a result of higher grain and fodder yield of sorghum as well as chickpea with the same treatment.

Introduction

Continuous use of only chemical fertilizers impure soil health reduces crop inputs responses and is not able to sustain crop productivity. Research evidences showed that integration of biological sources of nutrients with limited chemical fertilizers may be helpful in improving soil health and sustaining the crop productivity. INM is the most efficient and practical way to mobilize all the available, accessible and affordable plant nutrient sources in order to optimize the productivity of the crops/cropping systems and economic return to the farmer. A comprehensive literature search revealed that

INM enhances crop yields by 8–150% compared with conventional practices, increases water-use efficiency, and the economic returns to farmers, while improving grain quality and soil health and sustainability (Wei Wua and Baoluo Ma,2015).

Besides nutrients availability, FYM also improves soil physical characteristics such as structures, porosity and water-holding capacity through increased organic matter content of soil. FYM when applied in conjunction with biofertilizers, supplies energy to beneficial microorganisms including Azotobacter and PSB. Organic sources of nutrients applied to the preceding crop benefits the succeeding crop to a great extent (Hedge and Dwivedi, 1992). Azospirillum spp. have been identified mainly as rhizosphere bacteria.

They proliferate in the rhizosphere (soil fraction affected by root activities) of numerous plant species of many families. After establishing in the rhizosphere in sufficient numbers, they usually, but not always, promote the growth of the host plant (Bashan and Holguin 1997). The use of PSB is considered to increase the efficiency of native as well as applied phosphorus with the secretion of organic acids (Gaur, 1990). There is an urgent need of enhancing the availability of phosphate to crop, by use of PSB cultures. The INM, however, helps in maintaining the productivity of soil and improves fertilizer-use efficiency.

Thus, it economizes the use of chemical fertilizers by influencing the yield of kharif crop (Bejbaruha *et al.,* 2009) Therefore, the present study was undertaken with a view to find out the efficient and economic combination of organic, inorganic fertilizers and biofertilizers under sorghum-chickpea cropping sequence for getting more yield and net returns under rainfed conditions.

Materials and Methods

The experiment was conducted at Sorghum Research Unit Dr.Panjabrao Deshmukh Kruhi Vidhyapeeth, Akola, Maharashtra, during the rainy (kharif) and winter (rabi) seasons of 2013-2015. Nine Nutrient application treatments (INM) were assessed during Kharif for Sorghum and in rabi chickpea was grown on same site same randomization without any RDF in three replication in RBD on clayey soil, having pH 8.32 and electrical conductivity 0.28 dS/m.

It was medium in organic carbon (0.53 %), low in available nitrogen (232 kg/ha), low in available phosphorus (20.34 kg/ha) and high in available potassium (365 kg/ha). The experiment was laid out in randomized block design and nine nutrient application treatments (INM) were assessed during Kharif for Sorghum and in rabi chickpea was grown without any RDF in three replication (Table 1) Recommended doses of inorganic fertilizers consisting of 80 kg N and 40 kg each of P_2O_5 and K_2O/ha were applied to sorghum only and rabi Chickpea was grown on residual soil nutrients. For sorghum basal dose of N as per the treatment and remaining P and K was applied through chemical fertilizers. N was applied in 2 splits, half at sowing and remaining N was applied 30 days after sowing.

Nitrogen, phosphorus and potassium were applied through urea, single superphosphate and muriate of potash, respectively. The FYM and vermicompost were applied based on the nitrogen equivalent basis and nutrient requirement of sorghum and biofertilizers used in the form of seed inoculation were Azospirillum and phosphate-solubilizing bacteria. Sorghum (CSH-14) and chickpea (JAKI- 9218) were sown using seed rates of 7.5-10 kg /ha and 75-85 kg/ha with a spacing of 45 cm x 15 cm and 30 cm x 10 cm for

sorghum and chickpea respectively. Sorghum was sown in second fortnight of July and harvested during 1st week of November. During rabi season, chickpea was grown on the residual nutrient source and none of the fertilizers were applied to it. Chick pea was sown in 2nd week of November and harvested in 1st week of March during each year of experimentation. The crop sequence received total rainfall of 946.4 mm in 2013-14, 623.6 mm in 2014-15 and 796.5 mm in 2015-16 during the crop growth periods. The data on yield of sorghum and chickpea were recorded. The data was analyzed statistically as per Panse and Sukhatme (1967). The monetary return was calculated on pooled mean basis.

Results and Discussion

The application of 75% RDN through inorganic fertilizer+25% RDN through FYM+ seed treatment with microbial fertilizers PSB+ Azospirillum recorded significantly higher grain as well as fodder yield however it was at par with 75% RDN through inorganic fertilizer+25% RDN through vermicompost+ seed treatment with microbial fertilizers PSB+ Azospirillum. As a result of better soil conditions and moisture storage in soil integrated nutrient management treatments had recorded better crop growth and yield attributing characters than only inorganic fertilizer application resulted in to higher yield of grain as well as fodder of sorghum. Similarly significantly maximum Grain yield and dry fodder yield of chickpea was recorded with the residual effect the same treatment (T_7) which was at par with application of 75% RDN through inorganic fertilizer+25% RDN through vermicompost+ seed treatment with microbial fertilizers PSB+ Azospirillum(T_8). Significantly maximum sorghum equivalent yield(q/ha) was recorded with the application of 75% RDN through inorganic fertilizer+25% RDN through FYM+ seed treatment with microbial fertilizers PSB+ Azospirillum(T_7). However, it was at par with (T_8) Results of long-tern fertilizer experiments further supported the beneficial role of farmyard manure in enhancing apparent use efficiency of fertilizer NPK added maintaining yield stability in multiple cropping systems (Nambiar 1994).The results clearly showed the favorable effect of combined application of manures ,fertilizers and biofertilizers than inorganic fertilizers applied alone.

Economic Studies

Gross monetary Returns

The pooled GMR (Rs/ha) of kharif sorghum, rabi chickpea and of system was significantly maximum with the application of 75% RDN through inorganic fertilizer+25% RDN through FYM+ seed treatment with microbial fertilizers PSB+ Azospirillum, however it was at par with 75% RDN through inorganic fertilizer+25% RDN through vermicompost+ seed treatment with microbial fertilizers PSB+ Azospirillum. It might be attributed to higher yield levels in these treatments.

Net monetary returns

The pooled NMR (Rs/ha) of kharif sorghum, rabi chickpea and of system was significantly maximum with the application of 75% RDN through inorganic fertilizer+25% RDN through FYM+ seed treatment with microbial fertilizers PSB+ Azospirillum and it was superior over all other treatments.

B:C ratio of system

The B:C ratio of system was maximum with the application of 75% RDN through inorganic fertilizer+25% RDN through FYM+ seed treatment with microbial fertilizers PSB+ Azospirillum to kharif sorghum.

Table.1 Treatment details (Kharif- Sorghum)

T1	**100% RDN through inorganic fertilizer**
T2	50% RDN through inorganic fertilizer+50% RDN through FYM
T3	75% RDN through inorganic fertilizer+25% RDN through FYM
T4	50% RDN through inorganic fertilizer+50% RDN through vermicompost
T5	75% RDN through inorganic fertilizer+25% RDN through vermicompost
T6	50% RDN through inorganic fertilizer+25% RDN through FYM+25% RDN through vermicompost
T7	75% RDN through inorganic fertilizer+25% RDN through FYM+ seed treatment with microbial fertilizers PSB+ Azospirillum
T8	75% RDN through inorganic fertilizer+25% RDN through vermicompost+ seed treatment with microbial fertilizers PSB+ Azospirillum
T9	75% RDN through inorganic fertilizer+seed treatment with microbial fertilizers PSB+Azospirillum

(Treatments were applied to *Kharif* Sorghum only and *Rabi* Chickpea was grown on residual soil nutrients.)

Table.2 Pooled Grain and Dry fodder yield (q/ ha)of sorghum and chickpea and Sorghum Equivalent Yield (q/ha) as influenced by different treatments

Treatment details	**Grain and Dry fodder yield (q/ ha) of sorghum.**		**Grain and Dry fodder yield (q/ ha) of chickpea**		**Sorghum Equivalent Yield (q/ha)**
N1:100% RDN(IF)	26.88	113.43	11.23	17.23	64.31
N2:50% RDN(IF) +50% RDN FYM	27.25	113.85	13.22	18.75	71.31
N3:75% RDN (IF) +25% RDN FYM	27.76	114.44	12.03	18.82	67.86
N4:50% RDN (IF)+50% RDN VC	29.18	125.79	11.42	18.06	67.24
N5:75% RDN(IF) +25% RDN VC	29.80	123.80	11.77	19.82	69.05
N6:50% RDN(IF) +25% RDN FYM+25% RDN VC	25.80	112.68	11.62	17.91	64.54
N7:75%RDN(IF)+25%RDN FYM+ST(PSB+ Azspirillum)	31.62	131.56	14.21	21.06	79.99
N8:75% RDN(IF) +25% RDN ST (PSB+ Azospirillum)	31.14	124.14	13.04	19.27	75.59
N9:75% RDN(IF) + ST (PSB+ Azospirillum)	24.63	102.63	9.33	15.85	55.73
SE(m) ±	**0.48**	**1.02**	**0.58**	**0.63**	**2.04**
CD P=0.05	**1.37**	**2.87**	**1.65**	**1.77**	**5.78**

RDN: Recommended dose of nitrogen, FYM: Farm yard manure, VC: Vermicompost, ST:Seed Treatment, IF:Inorganic fertilizer

Table.3 Pooled GMR (Rs/ha) ,NMR(Rs/ha) and B:C Ratio of Sorghum, Chickpea and System as affected by different Treatments

Treatments	GMR (Rs/ha)			COC System (Rs/ha)	NMR(Rs/ha)			B:C Ratio System
	Sorghum	Chick pea	System GMR		Sorghum	Chick pea	System NMR	
N1:100% RDN(IF)	69479	36517	105996	33000	49979	23017	72996	2.21
N2:50% RDN(IF) +50% RDN FYM	70159	42904	113063	41445	42213	29404	71617	1.73
N3:75% RDN (IF) +25% RDN FYM	71084	39136	110221	34567	50018	25636	75654	2.19
N4:50% RDN (IF)+50% RDN VC	76089	37154	113243	35378	54211	23654	77865	2.20
N5:75% RDN(IF) +25% RDN VC	76549	38375	114924	35409	54641	24875	79516	2.25
N6:50% RDN(IF) +25% RDN FYM+25% RDN VC	67650	37789	105439	36975	44175	24289	68463	1.85
N7:75%RDN(IF)+25 %RDN FYM+ST(PSB+ Azspirillum)	82795	46170	128965	34817	61479	32670	94148	2.70
N8:75% RDN(IF) +25% RDN ST (PSB+ Azospirillum)	80190	42366	122555	35659	58031	28866	86897	2.44
N9:75% RDN(IF) + ST (PSB+ Azospirillum)	63345	30415	93760.4	32000	44845	16915	61760	1.93
SE(m) ±	**383**	**1881**	**1948**	**-**	**383**	**1881**	**1948**	**-**
CD P=0.05	**1082**	**5319**	**5508**	**-**	**1082**	**5319**	**5508**	**-**

Nawale et. al., (2009) also recorded significantly highest value for nutrient uptake, gross returns, net returns and maximum value for benefit : cost ratio of succeeding chickpea with residual effect of 25 % N through FYM + 25 % N through vermicompost + 50 % N through RDF applied to forage sorghum compared to the application of reduced or higher value of RDF in combination with the organic manures or alone inorganic fertilizer to preceding forage sorghum.

Thus, it can be concluded that, integration of inorganic fertilizers (75 per cent RDF) and organic manures (FYM) @ 2.5 ton per ha and seed treatment with biofertilizers to sorghum crop followed by chickpea without application of recommended dose is the best proposition to get the high productivity and profitability of sorghum and chickpea sequence. Similar results were obtained by Gawai and Pawar (2006).

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