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Evaluation of natural farming practices on productivity and economics of *rabi* sorghum in Northern transition zone of Karnataka

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Abstract
Field experiment was carried out on a fixed site during *rabi* season for two years at Main Agricultural Research Station, Dharwad to evaluate different farming practices on crop yields and economics of *rabi* sorghum. The results revealed that, recommended package of practices (1351 kg ha^{-1}) recorded significantly higher yield over natural and organic farming practices and it was found to be on par with integrated nutrient management-conventional farming plant protection (1284 kg ha^{-1}). Whereas, organic farming, integrated nutrient management-conventional farming plant protection and integrated nutrient management-natural farming plant protection were found to be on par with each other. Among the different farming practices, Natural farming: *Beejamrit* + *Ghanjeevamrit* + *Jeevamrit* + Mulching + Intercropping recorded significantly higher gross returns (₹ 45150 ha^{-1}), net returns (₹ 24294 ha^{-1}) compared to organic farming, INM and RPP and benefit cost (B: C) ratio was superior with NF: B+G+J+I (2.22).

Keywords: Natural farming, organic farming, integrated nutrient management

Introduction

Natural farming is an agro ecological approach that minimizes dependence on agricultural inputs like fertilizers and pesticides (Palekar, 2010) [5]. There are four main principles of natural farming *viz*., *beejamrit*, *jeevamrit*, mulching and *whaphasa* (soil aeration which results from the application of *jeevamrit* and mulching). Indigenous pesticide decoctions of leaves with cow urine such as *neemastra*, *agniastra* and *bramhastra* are introduced. Even though natural farming renders benefits like replenishing soil health and reduced cost on inputs somehow we have to sacrifice for total crop yields. The practice of natural farming system over a large-scale without scientific evaluation might affect the nation's agricultural production levels and may threaten food security.

Sorghum [*Sorghum bicolor* (L.) Moench], the fifth most important cereal crop on the globe and is traditionally grown for grain both as food (Africa and India) and as animal feed (developed countries like USA, Australia *etc.*) and stalks as animal fodder. Because of its drought-adaptation capability, sorghum is a preferred crop in tropical, warmer and semi-arid regions of the world with high temperature and water stress with the threat of climate change looming large on the crop productivity, sorghum being a drought-hardy crop, will play an important role in food, feed and fodder security in dryland economy (Rajendra Prasad *et al.*, 2002) [6]. In India, sorghum is grown over an area of 4.24 m ha with a production of 4.78 m t and productivity of 1128 kg ha^{-1} (Anon., 2021) [1]. Karnataka stands second with respect to area and production after Maharashtra. In Karnataka, sorghum covers an area of 0.74 m ha with a production of 0.88 m t and productivity of 1187 kg ha^{-1} (Anon., 2021) [1].

Materials and Methods

The experiment was carried out at Institute of Organic Farming (AI-NPOF), University of Agricultural Sciences, Dharwad during 2020-21 and 2021-22 and the results of pooled analysis were considered for the present article. Geographically, Dharwad is situated in the Northern Transition Zone (Zone-8) of Karnataka lies 15° 07' North latitude, 76° 06' East longitude and at an altitude of 678 m above the mean sea level (MSL). The soil of the experimental site was medium deep black clay loam in texture (*Vertisol*) having medium organic carbon content (0.56 %), low in available nitrogen content (252.60 kg ha^{-1}), high in available phosphorus

(24.52 kg ha^{-1}) and potassium (345.86 kg ha^{-1}). *Rabi* sorghum (Variety: SPV 2217) was grown as rainfed crop during *rabi* season with spacing of 45 cm x 15 cm. The experiment was laid out in randomized complete block design with eleven treatments and three replications. Treatment details: T_1: Control, T_2: Natural Farming (NF): *Beejamrit* (B) + *Ghanjeevamrit* (G) + *Jeevamrit* (J) + Mulching (M) + Intercropping (I), T_3: Natural Farming (NF): Mulching (M) + Intercropping (I), T_4: Natural Farming (NF): *Ghanjeevamrit* (G) + *Jeevamrit* (J) + Mulching (M) + Intercropping (I), T_5: Natural Farming (NF): *Beejamrit* (B) + Mulching (M) + Intercropping (I), T_6: Natural Farming (NF): *Beejamrit* (B) + *Ghanjeevamrit* (G) + *Jeevamrit* (J) + Intercropping (I), T_7: Natural Farming (NF): *Beejamrit* (B) + *Ghanjeevamrit* (G) + *Jeevamrit* (J) + Mulching (M), T_8: Organic farming (OF), T_9: Integrated Nutrient Management- natural farming plant protection (INM-NFPP), T_{10}: Integrated Nutrient Management- conventional farming plant protection (INM-CFPP) and T_{11}: Recommended Package of Practices (RPP). The inorganic fertilizers were applied as per the recommendations to RPP (50:25 N:P_2O_5 kg ha^{-1}) and INM (25:12.5 N:P_2O_5) kg ha^{-1} practices through DAP, Urea and MOP. The organic manures *viz.*, farmyard manure (FYM), vermicompost (VC) and neem cake (NC) were analysed for their nutrient content before application for making nitrogen equivalent nutrient application. In organic farming (FYM: 2 t ha^{-1}, VC: 3.2 t ha^{-1} and NC: 250 kg ha^{-1}) and INM (FYM: 1 t ha^{-1}, VC: 1.6 t ha^{-1} and NC: 125 kg ha^{-1}), 100 percent and 50 percent of organic manures were applied two weeks before sowing, respectively. In RPP, INM and organic farming treatments, seed treatment with *Azospirillum* and PSB both @ 500 g ha^{-1} seeds was done. In natural farming (NF) practices, seeds were treated with *beejamrit* and soil application of *ghanjeevamrit* @ 250 kg ha^{-1} a day before sowing and mulching was done with maize straw (5 t ha^{-1}) after sowing and foliar application of 10 percent *jeevamrit* at flowering and grain filling stage in respective treatments was done. In *rabi* sorghum, stem borer infestation occurred, chlorantraniliprole @ 0.2 ml l^{-1} for RPP and INM-CFPP treatments, neem oil @ 5 ml l^{-1} for organic farming and *neemastra* @ 250 l ha^{-1}, *agniastra* @ 3% and *brahmastra* @ 3 % for all natural farming and INM-NFPP plots were undertaken as plant protection measures. In natural farming practice, sprays of *agniastra* and *brahmastra* @ 3 % were taken time to time as a prophylactic measure as well in *rabi* sorghum.

The data collected from the experimental field were subjected to statistical analysis as described by Gomez and Gomez (1984) [2] and the mean values were subjected to DMRT.

Results and Discussion

Among different farming practices, recommended package of practices (1351 kg ha^{-1}) and INM-CFPP (1284 kg ha^{-1}) recorded significantly higher sorghum grain yield as compared to organic farming and natural farming practices. Whereas, organic farming (1196 kg ha^{-1}), INM-NFPP (1219 kg ha^{-1}) and INM-CFPP (1284 kg ha^{-1}) were found to be on par with each other. However, organic farming recorded significantly higher sorghum grain yield than natural framing (936 kg ha^{-1}). Among the natural farming practices, the treatment comprising all components *i.e.*, NF: B+G+J+M+I (936 kg ha^{-1}) recorded significantly higher sorghum grain yield and it was found to be on par with rest of the NF treatments except NF: M+I and NF: B+M+I (Table 1). Reduction of sorghum grain yield in NF: B+G+J+M+I (1196 kg ha^{-1}) was to the extent 21.72 percent over organic farming, 23.22 percent over INM-NFPP, 27.10 percent over INM-CFPP and 30.72 percent over RPP. This study clearly shows that sorghum yields were increased to a greater extent when organic plus inorganic manures were applied to the crop. Similar results were obtained by Solaiappan (2002) [8] and he found that combined application of organic manure and recommended level of inorganic fertilizer gave significantly and consistently higher sorghum grain yield. Similar work was reported by Halemani *et al.* (2003) [3] in cotton. The sorghum grain yield in organic farming was superior over natural farming treatments due to the application of 100 percent organics equivalent to RDN through FYM + vermicompost + neem cake and biofertilizers like *Azosprillum* and PSB. The increase in sorghum grain yield in organic farming to the extent of 27.78 percent over NF: B+G+J+M+I, natural farming. Similarly, significantly higher grain yield was produced with organic production system as compared to Subhash Palekar Natural Farming system in *rabi* sorghum (Kudari and Babalad, 2021) [4].

The crop yields of chickpea were converted into sorghum equivalent yield to interpret the response of intercropping in natural farming treatments and comparing with other farming practices where intercropping was not followed (Table 1). Among different farming practices, NF: B+G+J+M+I (1479 kg ha^{-1}) recorded significantly higher sorghum equivalent yield (SEY) and it was on par with NF: G+J+M+I (1436 kg ha^{-1}) and NF: B+G+J+I (1434 kg ha^{-1}).

With respect to economics, NF: B+G+J+M+I recorded significantly higher gross returns (₹ 45150 ha^{-1}), net returns (₹ 24294 ha^{-1}) compared to organic farming, INM and RPP. B: C ratio was superior with NF: B+G+J+I (2.22) and it was found to be on par with all natural farming treatments except NF: B+G+J+M. However, RPP recorded significantly higher net returns and B: C ratio (₹ 16828 ha^{-1} and 1.69, respectively) compared to organic farming, INM-NFPP and INM-CFPP (Table 1). Significantly lower net returns and B: C ratio was observed with organic farming (₹ 428 ha^{-1} and 1.01, respectively). This was mainly due to lower cost of cultivation and also income from intercrop (chickpea) which in turn resulted in higher sorghum equivalent yield in natural farming practices. Significantly lower net returns (₹ 428 ha^{-1}) and B: C ratio (1.01) were obtained with organic farming as the cost of cultivation was significantly higher in this treatment. The B: C ratio was significantly higher under natural farming treatments ranging from 2.10 to 2.22 which indicates more returns per rupee invested than organic farming, INM practices and RPP. Similar results were reported by Kudari and Babalad (2021) [4] in *rabi* sorghum and Shivanand Goudra (2022) [7] in sugarcane.

Table 1: Sorghum grain yield, sorghum equivalent yield and economics of *rabi* sorghum as influenced by different farming practices (pooled data)

Treatments	Grain yield (kg ha^{-1})	Seed yield of chickpea (kg ha^{-1})	Sorghum equivalent yield (kg ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B: C ratio
T_1: Control	710^{d}	-	710^{f}	21637^{f}	4886^{d}	1.29^{b-d}
T_2: NF: B+G+J+M+I	936^{c}	332	1479^{a}	45150^{a}	24294^{a}	2.16^{a}
T_3: NF: M+I	801^{d}	299	1291^{cd}	39414^{cd}	21401^{a}	2.19^{a}
T_4: NF: G+J+M+I	921^{c}	315	1436^{ab}	43828^{ab}	22975^{a}	2.10^{a}
T_5: NF: B+M+I	810^{d}	305	1309^{cd}	39951^{cd}	21934^{a}	2.22^{a}
T_6: NF: B+G+J+I	912^{c}	319	1434^{ab}	43760^{ab}	23858^{a}	2.20^{a}
T_7: NF: B+G+J+M	921^{c}	-	921^{e}	28067^{e}	10233^{c}	1.57^{bc}
T_8: OF	1196^{b}	-	1196^{d}	36488^{d}	428^{e}	1.01^{d}
T_9: INM-NFPP	1219^{b}	-	1219^{d}	37184^{d}	7847^{cd}	1.27^{cd}
T_{10}: INM-CFPP	1284^{ab}	-	1284^{cd}	39135^{cd}	9241^{c}	1.31^{b-d}
T_{11}: RPP	1351^{a}	-	1351^{bc}	41195^{bc}	16828^{b}	1.69^{b}
S.Em.±	31	-	37	1118	1118	0.05

B: *Beejamrit*, G: *Ghanjeevamrit*, J: *Jeevamrit*, M: Mulching, I: Intercropping, NF: Natural Farming, OF: Organic Farming, INM: Integrated Nutrient Management, CFPP: Conventional Farming Plant Protection, NFPP: Natural Farming Plant Protection and RPP: Recommended Package of Practices.

Means followed by same letter (s) within a column are not significantly differed by DMRT (P=0.05)

Conclusion

The study revealed that, RPP and INM-CFPP recorded significantly higher yield over natural farming practices. Whereas, organic farming, INM-NFPP and INM-CFPP were found to be on par with each other. Among the different farming practices, NF: B+G+J+M+I recorded significantly higher gross returns, net returns and B: C ratio compared to organic farming, INM and RPP.

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