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Effect of natural farming, organic farming, and recommended package of practices on yield and economics of irrigated wheat (*Triticum aestivum*)

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India is upscaling to achieve its trillion economies by 2024–25 with the current GDP of 8.4% (Anonymous 2021). The agriculture sector proved to be the most powerful arm of the Indian economy by showing a positive contribution (around 4.5%) to the GDP during the covid pandemic. It is the only sector which was sustained the Indian economy. But the current conventional agricultural system is associated with the huge cost of cultivation, atmospheric pollution, human health issues, etc. To revert this system, some alternative ways of agriculture have been popped up such as organic farming and natural farming practices. The current article fulfills to the various sustainable development goals (SDG) like SDG 1, 2, 3, 6, 12, and 13.

Zero budget natural farming (ZBNF) is a most spoken topic in the recent promulgated in India by Padma Shree awardee Shri Subhash Palekar who demonstrated the farming procedures for the social and economic growth of our farmers (Shankaranna 2018). The Indian prime minister recently addressed the farmers to adopt natural farming to minimize the cost of cultivation, and increase yields. The ZBNF method is meant to check the input costs by eliminating the need for expensive fertilizers, pesticides, protect soil health, and conserve water resources. Senior agricultural scientists had also expressed concern about a wholesale shift to unproven methods. The Indian Council for Agricultural Research (ICAR), New Delhi, India is conducting ongoing studies on the impact of ZBNF methods on productivity, economics, and soil health at multiple locations of India, but has yet to get desired and supportive results. By keeping an eye on the current situation, this comparative study was conducted to support the impact of natural farming on the cost of cultivation of wheat (*Triticum aestivum* L.) as compared to organic farming (OF) and recommended package of practices (RPP).

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A field experiment was conducted at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad (UASD), Karnataka during winter (*rabi)* season 2020–21. The experiment was laid out in split-plot design with four main plot treatments (CU_1: Cow urine @10%, CU_2: Cow urine @25%, CU_3: Cow urine @50%, and CU_4: Cow urine @100%), four sub-plot treatments (JA_1: Jeevamrutha as per ZBNF recommendations, JA_2: Jeevamrutha @25%, JA_3: Jeevamrutha @50% and JA_4: Jeevamrutha @100%) under natural farming and two uneven controls (C_1: Organic farming practice and C_2: Recommended package of practices), and all the treatments were replicated thrice.

The variety 'UAS- 304' of wheat was chosen to be sown in a plot size of 4.5 × 3.2 m for each treatment. The sowing operation was carried out with the help of bullock drawn seed drill (pora method) by maintaining 22.5 cm row spacing. The wheat seeds were treated with beejamrutha for all the natural farming treatments, and azospirillum, and P- solubilizing bacteria for the recommended package of practice and organic farming practice treatments prior to the sowing. The seed rate was maintained @150 kg/ha, and covered with bullock drawn harrowing on 2nd November 2020.

The common application of Ghanajeevamrutha @1000 kg/ha was applied in two equal splits on the day of sowing operation to all the natural farming treatments, and at 30 DAS, and thoroughly mixed in the soil through intercultivation. Mulching was done with crop residues @5 t/ha after intercultivation. The common soil drenching with jeevamrutha (5 times) was done @500 litre/ha at every 21 days interval from 21–93 DAS as per all the natural farming plots. The N, P, and K fertilizers were applied based on the recommendation of the UASD package of practices by calculating in the form of Urea, DAP, and MOP to the RPP treatment to supply fertilizers $N:P_2O_5:K_2O$ @100:60:40 kg/ha. The recommended nitrogen doses were applied in three splits at the time of sowing as basal, tillering, and flowering @50:25:25 kg/ha, respectively. The entire dose of phosphorus, and potassium was applied as basal dose only.

In organic farming practices, FYM, and Vermicompost were incorporated into the soil equivalent to 100% recommended dose of nitrogen-based on its N content.

The treatment formulations were made by the v/v method, and sprayed with suitable dilution with water. Viewing that, jeevamrutha was prepared as per the procedure and desi cow urine was collected from natural farming project cattle shed farm and filtered properly before spraying to the crop foliage as per treatments. To prepare 5% jeevamrutha, 5 ml of jeevamrutha was diluted in 95 ml of water. To maintain the uniformity in spray solutions, the requirement of jeevamrutha, and cow urine was adjusted with a recommended water volume of 500 litre/ha for spray. In the similar fashion the jeevamrutha 5%, 7.5%, 10%, 25%, 50% and 100% spray solutions were prepared, and sprayed from 30–93 DAS at 3 weeks intervals. Similarly, cow urine @10%, 25%, 50%, and 100% spray solutions were prepared and sprayed from 21–105 DAS at 3 weeks intervals as per the treatments

The wheat crop was harvested separately at 120 DAS from the net plot area of the respective treatments. After complete drying, the weight of the total dry matter from the net plot was noted. The produce was cleaned and weighed after threshing with thresher. Grain yield and straw yield per net plot area were encrypted on a hectare basis and figured in kg/ha.

The economical parameters namely gross return (₹/ha) was worked by grain yield, and straw yield (kg/ha) with the market price of wheat grain and university fixed price for straw yield (₹/ha). The cost of cultivation was determined by summoning up all the costs incurred for the operations carried out during the study from land preparation to harvesting and inputs used with their market prices and preparation to market. Net returns (₹/ha) obtained by deducting the cost of cultivation (₹/ha) from gross returns, and benefit-cost ratio (B:C) by dividing gross returns (₹/ha) by cost of cultivation (₹/ha). The recorded data was subjected to analyze statistically by using a split-plot design with uneven control as per the procedure given by Gomez and Gomez, 1984.

Yield: Higher grain and straw yield was recorded in the recommended package of practice (3670 and 7138 kg/ha) than organic farming practices (3012 and 5422 kg/ha), and all other natural farming treatment combinations. Among the natural farming practice, the treatment combination, i.e. cow urine @50 % + jeevamrutha @100% recorded significantly higher grain and straw yield (3066 and 3710 kg/ha) than all other combinations, whereas the organic farming practice was found on par with it (Table 1).

The increased grain yield under the RPP was 22% higher than OF practices (3012 kg/ha). The best treatment from natural farming practice, i.e. cow urine @50% + jeevamrutha @100% (3066 kg/ha) recorded a 16% lower yield than the RPP, whereas the OF practice was on par with the best natural farming treatments. The higher yield resulted in the UASD RPP was due to a steady supply of nutrients in an integrated way through FYM @7.5 t/ha,

Table 1 Grain and straw yield of wheat as influenced by different application of cow urine, jeevamrutha, OF, and RPP

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)
Main plot: Cow urine (CU) at 3 weeks interval from 21–105 DAS		
CU_1: 10%	2195	2654
CU_2: 25%	2410	3145
CU_3: 50%	2547	3156
CU_4: 100%	2755	3432
SEm±	51.99	57.96
CD (P=0.05)	179.89	200.56
Sub plot: Jeevamrutha (JA) at 3 weeks interval from 30–93 DAS		
JA_1: JA as per ZBNF recommendation (5%, 7.5%, 10% at vegetative, flowering, and panicle initiation stage)	2218	2968
JA_2: 25%	2389	2978
JA_3: 50%	2646	3216
JA_4: 100%	2655	3226
SEm±	47.30	19.54
CD (P=0.05)	138.07	57.05
Interactions : Cow urine (CU) × Jeevamrutha (JA)		
T_1- CU_1 JA_1	1582	2155
T_2- CU_1 JA_2	2075	2559
T_3- CU_1 JA_3	2546	3009
T_4- CU_1 JA_4	2577	2895
T_5- CU_2 JA_1	2734	3327
T_6- CU_2 JA_2	2411	2976
T_7- CU_2 JA_3	2495	3145
T_8- CU_2 JA_4	2550	3132
T_9- CU_3 JA_1	2508	3216
T_{10}- CU_3 JA_2	2650	3275
T_{11}- CU_3 JA_3	2798	3473
T_{12}- CU_3 JA_4	3066	3710
T_{13}- CU_4 JA_1	2047	3009
T_{14}- CU_4 JA_2	2420	3127
T_{15}- CU_4 JA_3	2743	3327
T_{16}- CU_4 JA_4	2428	3214
SEm±	97.03	67.12
CD (P=0.05)	283.22	195.91
To compare controls with other treatments (T_1 + T_{16})		
C_1- Organic farming practices (OF)	3012	5422
C_2- Recommended package of practices (RPP)	3670	7138
SEm±	101.27	149.71
CD (P=0.05)	291.06	430.27

Table 2 Economics of wheat cultivation as influenced by application of cow urine, jeevamrutha, OF and RPP

Treatment	Cost of cultivation (₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	B:C ratio
Main plot: Cow urine (CU) at 3 weeks interval from 21–105 DAS				
CU_1: 10%	51714	60857	7592	1.15
CU_2: 25%	53928	67086	10207	1.20
CU_3: 50%	54014	70704	15823	1.28
CU_4: 100%	54167	76499	20142	1.34
SEm±	-	1409.07	1276.73	0.02
CD (P=0.05)	-	4876.03	4418.07	0.08
Sub plot: Jeevamrutha (JA) at 3 weeks interval from 30–93 DAS				
JA_1: JA as per ZBNF recommendation (5%, 7.5%, 10% at vegetative, flowering, and panicle initiation stage)	51603	61816	8663	1.15
JA_2: 25%	52869	66319	11947	1.22
JA_3: 50%	54551	73358	15851	1.30
JA_4: 100%	56299	73653	17304	1.31
SEm±	-	1251.08	1191.18	0.02
CD (P=0.05)	-	3651.65	3476.79	0.06
Interactions: Cow urine (CU) × Jeevamrutha (JA)				
T_1- CU_1 JA_1	49940	44126	-5814	0.88
T_2- CU_1 JA_2	52189	57577	5388	1.09
T_3- CU_1 JA_3	54558	70406	15848	1.30
T_4- CU_1 JA_4	56373	71320	14947	1.34
T_5- CU_2 JA_1	54115	75837	21722	1.38
T_6- CU_2 JA_2	53752	66907	13155	1.20
T_7- CU_2 JA_3	54882	69325	14443	1.26
T_8- CU_2 JA_4	56774	70748	13973	1.29
T_9- CU_3 JA_1	54202	69723	15521	1.29
T_{10}- CU_3 JA_2	55328	73593	18265	1.32
T_{11}- CU_3 JA_3	56663	77676	21013	1.35
T_{12}- CU_3 JA_4	59238	85006	25768	1.41
T_{13}- CU_4 JA_1	54355	57580	3225	1.07
T_{14}- CU_4 JA_2	56220	67199	10979	1.26
T_{15}- CU_4 JA_3	58114	76025	17911	1.33
T_{16}- CU_4 JA_4	58824	67539	8715	1.14
SEm±	-	2584.78	2426.26	0.04
CD (P=0.05)	-	7544.45	7081.75	0.12
To compare controls with other treatments (T_1 + T_{16})				
C_1- OF	85147	85481	334	1.04
C_2- RPP	63642	104741	41099	1.59
SEm±	-	2644.47	2510.26	0.04
CD (P=0.05)	-	7600.29	7214.55	0.12

biofertilizers, and inorganic fertilizers, and split application of N in the form of urea at critical growth stages of the crop, and supplementation of P and K along with micronutrients (UASD Agriculture package of practices 2021).

Economics: Among the three respective practices, it was observed that the lower cost of cultivation was imposed in the case of natural farming treatments due to less cost associated with cow urine, jeevamrutha, and other inputs required for raising the crop. Whereas, the higher cost of cultivation was incurred in the case of organic farming due to the higher amount of bulky organic manures like FYM, vermicompost equivalent to 100% RDN. Recommended package of practices maintained an average cost of cultivation in between natural and organic farming which was a prime reason for getting higher profit (Table 2). When the natural farming treatments were compared with the organic and recommended practices, it was highlighted that considerably the higher gross return, net return, and B:C ratio (104741 ₹/ha, 41099 ₹/ha, and 1.59) were recorded in the RPP than OF practice (85481 ₹/ha, 334 ₹/ha, and 1.04), and best natural farming treatment combination (85006 ₹/ha, 25768 ₹/ha, and 1.41). This was mainly due to an average cost of cultivation, higher grain yield, straw yield, and gross returns. The best treatment cow urine @50% + jeevamrutha @100% (CU_3JA_4) recorded 98% higher net return than organic farming practice, and 59% lower net return than the recommended package of practices due to reduced cost of inputs, and producing grain yield equal to organic farming.

Hence, the study indicates to follow UASD recommended package of practices and natural farming by meeting the nutrient requirements through foliar application. The foliar application of jeevamrutha and cow urine will be able to supply the required nutrients, and can reduce the huge cost imposed in conventional farming. Several researchers obtained a good response of wheat to cow urine @10% (Korade *et al.* 2019, Prasanna *et al.* 2020), 50% (Pradhan *et al.* 2017), and 100% (Sadhukhan *et al.* 2018, Vanita *et al.* 2020). However, the information on the combined application of cow urine, and jeevamrutha and their concentration effect on irrigated wheat are very meager, and the concentration rate at which it is to be applied is not known under natural farming conditions.

SUMMARY

An experiment was carried out on a split-plot design with two uneven controls, viz. four foliar concentrations of cow urine, and jeevamrutha under natural farming which were compared with Organic farming (OF), and Recommended package of practices (RPP) given by University of Agricultural Sciences, Dharwad (UASD). The treatments were replicated thrice. The study found that the UASD RPP recorded significantly higher grain yield, straw yield, gross return, net return, and B:C ratio than OF and natural farming practices. The grain yield reduction in the best treatment (cow urine @50% + jeevamrutha @100%) was 16% lesser than RPP, and 2% higher than

OF. However, the cost of cultivation in natural farming with cow urine @50% + jeevamrutha @100% was lesser to the extent of 6.91 and 30.42% than UASD RPP and OF. Hence, the study indicates that irrigated wheat can be grown under UASD RPP followed by natural farming treatment more profitably.

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