E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; SP-7(8): 172-175
Received: 18-06-2024
Accepted: 23-07-2024

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Influence of modified natural farming application on nutrient content and uptake of maize under maize + cowpea intercropping system

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DOI: https://doi.org/10.33545/2618060X.2024.v7.i8Sc.1249

Abstract
The aim of this study was to evaluate the nutrient content (nitrogen, phosphorus and potassium) and their uptake of maize crop compared to the modified natural farming systems of nutrition. The field experiment was conducted during *kharif* 2022 at Research Farm of Centre of Organic and Natural Farming, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, main campus, Chatha. The experiment was comprised of seventeen treatments which were laid out in randomized block design with three replications. The treatment consisted of 50% N through FYM + Seed treatment with Beejamrit + Soil application Jeevamrit + Foliar application of Jeevamrit (T_{17}) shows maximum nutrient content and significantly highest nutrient uptake. The study conclusively indicated that modified natural farming application of Maize + Cowpea intercropping system the treatment (50% N through FYM + Seed treatment with Beejamrit + Soil application Jeevamrit + Foliar application of Jeevamrit) helped in enhancing the nutritional content and nutrient uptake.

Keywords: Modified, natural farming, Jeevamrit, FYM

Introduction
The most extensively cultivated cereal crops in the world, including India, are rice, wheat, and maize. These three crops are essential to ensuring global food security. The primary source of food energy in the globe is maize (*Zea mays* L.), which also contains a sizable amount of proteins, vitamins, and minerals. After rice and wheat, maize is the world's third-most important cereal crop and a major source of staple food for a large section of the global population. It grown under area of 10.4 million hectares with production 33.62 million tonnes and productivity 3349 kg of per hectare in India (Anonymous 2023) [2]. It presents a better potential for output than other cereal crops. Maize is a heavy feeder of plant nutrients and growing of these crops alone over the years will barren the land and cause for decline in productivity. Inclusion of legumes in rotation or raising them in association with these crops have been advocated by various workers to sustain the soil health and due importance was given for achieving higher yield. Cereals outperform leguminous crops in intercropping systems, presumably due to the varying timing of resource usage by the various crops. High analysis chemical fertilizers have been used in India to maintain the productivity of intercropping systems based on maize. In an intensive cropping system, chemical fertilizers can meet the nutrient requirements of these crops; nevertheless, frequent application of these fertilizers causes nutrient imbalances, which are harmful to crop productivity and soil health. Considering the stakes, an alternative to chemical farming was inevitable and led to the emergence of a new agricultural production system. Under this system the chemicals were replaced by farmyard manure, vermicompost, vermiwash, green manuring, etc. These help to increase the soil organic matter content, which ultimately improves the soil pH, structure, water holding capacity, cation exchange capacity, and availability of macro and micronutrients (Alabadan *et al.*, 2009) [1]. Besides organic farming, there is Natural Farming is also an alternative to chemical farming where in on-farm products are used as inputs by converting them into formulations such as jeevamrit and beejamrit.

Apart from supplying nutrients, this method helps increase the microbial population such as phosphorus solubilizing bacteria, plant growth-promoting rhizobacteria, etc. In natural farming is one such step towards environment friendly techniques that is taken to ensure sustainable agricultural production. Although, in natural farming, there is a significant need for desi cow dung and urine and virgin or forest soil. Working with nature to produce nutritious food, keep ourselves well and maintain the health of the land is the philosophy of natural farming (Devarinti, 2016) [5]. The key to natural farming is reducing the external inputs that harm the natural soil composition on the farm. With the similar principle but using local supplements, Subash Palekar in India has developed Zero-Budget Natural Farming (ZBNF).

Materials and Methods

The field experiments were conducted during *kharif* 2022 at Research Farm of Centre of Organic and Natural Farming, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, main campus, Chatha. The experimental site was situated at 32^0-40′ N latitude and 74^0-58′ E longitude with an altitude of 332 m above mean sea level in the Shiwalik Foothills. The soil of experimental site was sandy clay loam in texture and slightly alkaline in reaction. The experiment was comprised of seventeen treatments which were laid out in randomized block design with three replications. The treatments are Absolute control (T_1), Recommended organic package (T_2), Seed treatment with Beejamrit + Soil application of Jeevamrit + Foliar application of Jeevamrit (T_3), 25% N through FYM + Seed treatment with Beejamrit (T_4), 25% N through FYM + Soil application Jeevamrit (T_5), 25% N through FYM + Foliar application of Jeevamrit (T_6), 25% N through FYM + Seed treatment with Beejamrit + Soil application Jeevamrit (T_7), 25% N through FYM + Seed treatment with Beejamrit + foliar application Jeevamrit (T_8), 25% N through FYM + Soil application Jeevamrit + Foliar application Jeevamrit (T_9), 25% N through FYM + Seed treatment with Beejamrit + Soil application Jeevamrit + Foliar application of Jeevamrit (T_{10}), 50% N through FYM + Seed treatment with Beejamrit (T_{11}), 50% N through FYM + Soil application Jeevamrit (T_{12}), 50% N through FYM + Foliar application of Jeevamrit (T_{13}), 50% N through FYM + Seed treatment with Beejamrit + Soil application Jeevamrit (T_{14}), 50% N through FYM + Seed treatment with Beejamrit + Foliar application Jeevamrit(T_{15}), 50% N through FYM + Soil application Jeevamrit + Foliar application Jeevamrit (T_{16}), 50% N through FYM + Seed treatment with Beejamrit + Soil application Jeevamrit + Foliar application of Jeevamrit (T_{17}). The plant and grain samples were collected at harvest of maize crop for chemical analysis *viz*. nitrogen, phosphorus and potassium content (%) following standard methods of modified Kjeldahl's method (AOAC 1970) [3], vanado-molybdate phosphoric method (Jackson 1967) [10] and flame photometer technique (Jackson 1967) [10], respectively. The nutrient uptake by grain and straw of maize was computed with the help of following relationship:

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Nutrient content (\%)} \times \text{grain yield/straw yield (kg/ha)}}{100}$$

The data recorded on various aspects in the present study were subjected to the statistical analysis using analysis of variance as per procedure suggested by Gomez and Gomez (1984) [6].

Results and Discussion

Maximum content of nitrogen, phosphorus and potassium in grain and stover of maize (Table 1) and therefore, the uptake of respective nutrient (Table 2) was observed with the treatment 50% N through FYM + Seed treatment with Beejamrit + Soil application Jeevamrit + Foliar application of Jeevamrit (T_{17}) which was statistically at par with the 50% N through FYM + seed treatment with beejamrit + foliar application jeevamrit (T_{15}), recommended organic package (T_2), 50% N through FYM + seed treatment with beejamrit + foliar application jeevamrit (T_{16}) and 50% N through FYM + foliar application of jeevamrit (T_{13}). The cow urine rich in uric acid, a source of nitrogen was readily soluble and liquid form, one of the important compounds jeevamrit which was readily available to the plants directly influencing the nitrogen content of leaves (Patel *et al*., 2018) [12]. The organic manure is able to improve the soil aeration which resulted in better root growth thereby promoting root development. This resulted in higher crop yield and hence the uptake of nutrients (Chaudhary *et al*., 2016) [4]. These treatments improved nutrient availability and increased microbial population, which in turn might have enhanced the mobilization of nutrients and ultimately led to a higher concentration of nutrients in the crop. Additionally, the adoption of legume (*i.e*., cowpea) as intercrop with maize resulted in biological nitrogen fixation, which improved the soil nitrogen status and subsequently raised the nutrient uptake in maize + cowpea intercropping system these results are in conformity findings of Kumar (2015) [11].

Potkile *et al.* (2017) [13] reported that FYM was applied at the time of sowing has shown increasing nutrient availability and solubility in the soil, resulting in higher nutrient accumulation and transportation in plants leading to increased nutrient concentrations in both the grain and stover. Lowest nitrogen, phosphorus and potassium content as well as uptake in grain and stover was recorded in absolute control (T_1) where no manures and fertilizers were applied. Nutrient uptake is a function of grain or stover yield and content of respective nutrients. Therefore, improvement in both these factors resulted in higher uptake of added nutrients. The nitrogen sufficiency in the soil solution and higher grain or stover yield might be responsible for higher nitrogen uptake in in 50% N through FYM + Seed treatment with Beejamrit + Soil application Jeevamrit + Foliar application of Jeevamrit (T_{17}). The most pertinent explanation for a higher intake of nutrients could be attributed to the larger biomass production (Gupta and Bhadauria 2022) [8].

Table 1: Influence of modified natural farming application on nutrient concentration (%) in grain and stover of maize crop

	N Content (%)		P Content (%)		K Content (%)	
	Grain	Stover	Grain	Stover	Grain	Stover
Absolute control	1.05	0.37	0.23	0.13	0.36	1.01
Recommended organic package	1.12	0.41	0.26	0.13	0.41	1.13
Seed treatment with Beejamrit + Soil application of Jeevamrit + Foliar application of Jeevamrit*	1.08	0.40	0.22	0.12	0.38	1.07
25% N through FYM + Seed treatment with Beejamrit	1.08	0.40	0.21	0.11	0.37	1.01
25% N through FYM + Soil application of Jeevamrit	1.05	0.39	0.20	0.11	0.34	1.04
25% N through FYM + Foliar application of Jeevamrit*	1.06	0.39	0.19	0.11	0.35	1.02
25% N through FYM + Seed treatment with Beejamrit + Soil application of Jeevamrit	1.07	0.40	0.20	0.12	0.36	1.06
25% N through FYM + Seed treatment with Beejamrit + Foliar application Jeevamrit*	1.08	0.40	0.21	0.12	0.37	1.04
25% N through FYM + Soil application of Jeevamrit + Foliar application of Jeevamrit*	1.07	0.40	0.20	0.11	0.36	1.07
25% N through FYM + Seed treatment with Beejamrit + Soil application of Jeevamrit + Foliar application of Jeevamrit*	1.09	0.40	0.23	0.12	0.39	1.09
50% N through FYM + Seed treatment with Beejamrit	1.06	0.39	0.19	0.11	0.35	1.02
50% N through FYM + Soil application of Jeevamrit	1.07	0.40	0.20	0.11	0.36	1.00
50% N through FYM + Foliar application of Jeevamrit*	1.09	0.40	0.23	0.13	0.39	1.10
50% N through FYM + Seed treatment with Beejamrit + Soil application of Jeevamrit	1.08	0.40	0.22	0.12	0.38	1.06
50% N through FYM + Seed treatment with Beejamrit + Foliar application Jeevamrit*	1.14	0.41	0.25	0.13	0.42	1.14
50% N through FYM + Soil application of Jeevamrit + Foliar application of Jeevamrit*	1.10	0.40	0.24	0.12	0.40	1.12
50% N through FYM + Seed treatment with Beejamrit + Soil application of Jeevamrit + Foliar application of Jeevamrit*	1.15	0.42	0.26	0.14	0.43	1.19
SEm±	0.02	0.01	0.02	0.01	0.02	0.05
CD(5%)	NS	NS	NS	NS	NS	NS

Table 2: Influence of modified natural farming application on nutrient uptake (kg/ha) in grain and stover of maize crop

		N Uptake (kg/ha)			P Uptake (kg/ha)			K Uptake (kg/ha)		
		Grain	Stover	Total Uptake	Grain	Stover	Total Uptake	Grain	Stover	Total Uptake
T_1	Absolute control	14.06	9.12	23.18	3.00	3.08	6.08	4.84	24.66	29.50
T_2	Recommended organic package	26.27	17.76	44.03	5.86	5.39	11.25	9.54	48.87	58.41
T_3	Seed treatment with Beejamrit + Soil application of Jeevamrit + Foliar application of Jeevamrit*	22.42	15.38	37.80	4.63	4.53	9.16	7.95	41.28	49.24
T_4	25% N through FYM + Seed treatment with Beejamrit	19.26	13.42	32.68	3.76	3.53	7.29	6.16	33.81	39.98
T_5	25% N through FYM + Soil application of Jeevamrit	19.14	13.15	32.28	3.70	3.56	7.26	6.23	33.86	40.10
T_6	25% N through FYM + Foliar application of Jeevamrit*	19.92	13.29	33.21	3.59	3.72	7.31	6.55	34.04	40.59
T_7	25% N through FYM + Seed treatment with Beejamrit + Soil application of Jeevamrit	20.77	13.81	34.58	3.89	4.05	7.94	7.00	36.82	43.82
T_8	25% N through FYM + Seed treatment with Beejamrit + Foliar application Jeevamrit*	21.67	14.38	36.05	4.22	4.16	8.38	7.43	37.09	44.52
T_9	25% N through FYM + Soil application of Jeevamrit + Foliar application of Jeevamrit*	20.41	13.63	34.04	3.77	3.96	7.72	6.83	36.60	43.43
T_{10}	25% N through FYM + Seed treatment with Beejamrit + Soil application of Jeevamrit + Foliar application of Jeevamrit*	22.89	15.85	38.74	4.83	4.86	9.69	8.19	42.98	51.17
T_{11}	50% N through FYM + Seed treatment with Beejamrit	19.97	13.36	33.33	3.57	3.83	7.41	6.59	34.15	40.74
T_{12}	50% N through FYM + Soil application of Jeevamrit	20.35	13.57	33.92	3.86	3.87	7.73	6.78	34.32	41.10
T_{13}	50% N through FYM + Foliar application of Jeevamrit*	24.62	16.82	41.44	5.42	5.14	10.57	8.88	43.89	52.77
T_{14}	50% N through FYM + Seed treatment with Beejamrit + Soil application of Jeevamrit	22.03	15.23	37.26	4.50	4.46	8.96	7.78	40.61	48.39
T_{15}	50% N through FYM + Seed treatment with Beejamrit + Foliar application Jeevamrit*	27.02	17.80	44.82	5.96	5.42	11.38	10.04	49.40	59.45
T_{16}	50% N through FYM + Soil application of Jeevamrit + Foliar application of Jeevamrit*	25.66	17.13	42.79	5.59	5.17	10.75	9.31	47.54	56.85
T_{17}	50% N through FYM + Seed treatment with Beejamrit + Soil application of Jeevamrit + Foliar application of Jeevamrit*	27.64	17.94	45.58	6.18	5.91	12.09	10.12	49.42	59.54
	S.Em±	1.05	0.70	1.45	0.43	0.32	0.57	0.48	2.17	2.37
	CD(5%)	3.02	2.03	4.18	1.23	0.93	1.64	1.39	6.26	6.84

Conclusion

The study conclusively indicated that modified natural farming application of maize + cowpea intercropping system the treatment (50% N through FYM + Seed treatment with Beejamrit + Soil application Jeevamrit + Foliar application of Jeevamrit) helped in enhancing the nutrient content (nitrogen, phosphorus and potassium), their uptake and quality (crude protein content and protein yield) of maize crop than the organic and pure natural farming systems of nutrition.

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