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Research Paper

Productivity, profitability and nutrient uptake of soybean (*Glycine max*) as affected by foliar application of liquid organic manures under organic and natural farming practices

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ABSTRACT

The experiment was carried out at Main Agricultural Research Station, UAS, Dharwad, during *Kharif,* 2022–23 and 2023–24 with an aim to find out the insights into sustainable management strategies for soybean cultivation, balancing productivity with ecological conservation. The experiment consists of three farming practices in horizontal strips *viz*., Organic farming (OF), Natural farming (NF) and Intensification of natural farming (INF) and five liquid organic manures (LOM's) in vertical strips *viz*., Vermiwash (VW) @ 5%, Jeevamrutha (JA) @ 20%, panchagavya (PG) @ 5%, Cow Urine (CU) @ 10% and water spray). The field had been passed through the transitional period of three years which is essential to convert into chemical free farming. On pooled basis, the results were organic farming recorded higher seed yield, halum yield, gross return and higher macro (NPK) and micro nutrients (Fe, Mn, Zn & Cu) uptake than natural farming practices. However, harvest index, net return and B:C ratio's were higher with NF than both OF and INF. Among the LOM's, PG recorded higher yield, gross return, total N uptake and micro nutrients uptake than others. But, NF recorded higher HI (42.88), net returns (₹108931) and B:C ratio (3.96) than both OF and INF. The Seed and halum yields as well as gross returns of OF were compared with recommended package of practices (RPP). However, the best treatment NF recorded lesser NR by 16% and B:C ratio (0.39) than RPP.

Key words: Economics, Integrated natural farming, Macro & micro nutrients, Natural farming, Organic farming, Soybean, Uptake, Yield

The introduction of green revolution technologies in India, leads to increased food production during 1960's. On the other side, soil, water and air get polluted due to use of inorganic fertilizers and pesticides. Inorganic fertilizers damaged the soil physical properties like water holding capacity, water retention, aggregate stability and chemical properties by increasing the soil alkalinity and salinity (Pahalvi *et al*., 2021). Hence, now a days policy makers looking for alternative eco friendly farming practices which makes the soil fertile and minimal pollution to the environment. Eco friendly farming practices meets the needs of existing and future generations, while also ensuring profitability, environmental health, social and economic equity (Tal, 2018). It favours techniques that emulate nature to preserve soil fertility, prevent water pollution and protect biodiversity. Eco-friendly farming practices offer a solution to various problems like food insecurity, farmer's distress, health problems arising due to pesticide and fertilizer residue in food and water, environmental safety, biodegradation of agricultural wastes, global warming, climate change and natural calamities. It has also a potential to generate employment, thereby stemming the migration of rural youth. The government of India emphasizing more on natural farming through Bharathiya Prakruthika krishi Paddadathi (BPKP) through National Mission on Sustainable Agriculture (NMSA) and National Mission on Natural Farming. But NAAS and other academic institutes having ambiguity in benefits of natural farming. Under these circumstances, a study was conducted at UAS, Dharwad under a mega project validation of NF with other farming practices, the present study was conducted in soybean

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(*Glycine max*) to assess few eco friendly farming practices *viz*., organic farming, natural farming and combination of both organic and natural farming practices in terms of productivity, economics and nutrient uptake. Similarly, foliar application of liquid organic manures (LOM's) *viz*., Vermiwash, panchagavya, Jeevamrutha, Cow Urine and Water Sprays were assessed by how much yield reduction will be minimized by avoiding nutrient deficiency at critical stages of crop growth.

Soybean (*Glycine max*) is a well known oil seed as well as pulse crop belongs to family *Fabaceae* and sub family *Papilionaceae* having center of origin at South East Asia and is also called as 'golden bean', contains 40% good quality protein, rich in lysine and 20% oil high in essential fatty acids (Omega-6 and Omega-3). Additionally 26% carbohydrates, 4% minerals, 2% phospholipids, vitamin A, B, C, D, E and K are also contained. Soybean is rich and cheapest source of protein and fat, having multiple uses as food, cattle feed and pharmceutical uses. In India, soybean has emerged as main oilseed crop in a short span of time. It is termed as wonder crop because soybean being natural biological nitrogen fixer in the field that plays a vital role in increasing indigenous nitrogen fixation in soil (40 kg per ha) (Kumar, 2022). The study was conducted with an objective of finding the influence of different farming practices and foliar sprays of liquid organic manures on productivity, economics and plant macro and micro nutrient uptake as well as reducing the yield losses in pure natural farming and organic farming practices by combination of OF with NF practices.

MATERIALS AND METHODS

The experiment was laid out in strip plot design with three replications on *vertisols* of northern transitional zone of Karnataka (Zone- 8). The experiment was conducted with 'Dsb-34' variety with a spacing of 30 × 10 cm during *kharif*, 2022–23 and 2023–24 on permanant plots in both the years. Horizontal strip consisting of three farming practices viz., natural farming as per the protocol given by palekar, 2006, intensification of natural farming with organic farming practices, organic farming practices as per the UAS, Dharwad and vertical strip consisting of foliar application of liquid organic manures *viz*., Vermiwash (VW) @ 10%, panchagavya (PG) @ 5%, Jeevamrutha (JA) @ 20%, Cow Urine (CU) @ 10% and water spray (WS) as control along with two un even controls namely recommended package of practices (RPP) of UAS, Dharwad and 100 per cent chemical farming (CF). The foliar application of LOM's were done at critical crop growth stages *viz*., seedling stage, bud formation and flowering stage, pod formation stage and pod development stage. In natural farming (NF) the seeds were treated with *beejamrutha* before sowing and *Jeevamrutha* sprinkled on soil and crops at 21 days interval @ 500 l per ha from 21 DAS to 90 DAS (4 times). Exsitu green manuring of *Glyricidia* was grown on bunds and used as mulch at 30 DAS (5000 kg/ha). The pest and diseases were controlled through *neemastra*, *agniastra*, *Bramhastra*, *dashparni*, *shuntiastra* and sour butter milk. In integrated natural farming (INF) in addition to natural farming practices 50% of the organic manures (equivalent to 50% RDP applied in organic farming) were added. In organic farming the seeds were treated with *Rhizobium* and Phosphorus solubilizing bacteria (PSB) (1250 g each/ha) at the time of sowing. Addition of FYM @ 6.0 t/ha + organic manures were supplied equivalent to 100 % RDP through FYM (8.7 t/ha) and vermicompost (5.6 t/ha) @ 50% each, in addition to recommended dose of FYM. In recommended package of practices (RPP) the seeds were treated with *Rhizobium* and *Phosphorous solubilising bacteria* (1250 g per ha each). Recommended dose of fertilizers were applied @ 40: 80: 25 kg N:P_2O_5: K_2O along with FYM @ 6 t/ha and $ZnSo_4$ @ 12.5 kg/ha incorporated in to the soil. In chemical farming (CF), seeds were treated with vitavax @ 2 g/kg of seed and soil application of 40: 80: 25 kg N: P_2O_5: K_2O was followed. All the fertilizers were applied at the time of sowing in RPP and chemical farming. Foliar application of liquid organic manures (LOM's) were done as per the treatments in organic farming, natural farming and integrated natural farming at different critical stages.

The Seed yield and Haulm yield per plot was recorded separately and expressed as kg per ha. Harvest index (%) was calculated by dividing economic yield with total biological yield which included grain and stover (Donald, 1962).

$$Harvest\ index = \frac{Economic\ yield\ (kg\ per\ ha)}{Biological\ yield\ (kg\ per\ ha)} \times 100$$

For plant uptake analysis, five plants were randomly selected during harvest and allowed to dry and grinded into powder and sieved in 2 mm sieve and used for subsequent analysis. Total Nitrogen on the dry weight basis at harvest of soybean was estimated by micro Kjeldhal's method and expressed in percentage (Jackson,1973). Phosphorus estimated by Vanadomollybdo-phosphoric acid yellow colour method in the tri acid mixture (Jackson, 1973) by using spectrophotometer at 420 nm and expressed in percentage. It was converted into P_2O_5 by using a multiplication factor 2.29. Similarly, total potassium on the dry weight basis at harvest was estimated by flame photometer method as outlined by Jackson (1973) and expressed in percentage. It was converted into K_2O by using a multiplication factor 1.21. The concentrations of zinc, iron, manganese and copper in the filtrate were determined using Atomic absorption

spectrophotometer (AAS) as described by Jackson (1973).

Weather and soil data during crop growth period

The rainfall received during the experimental year (*kharif*, 2022 and *kharif*, 2023) was 1101.60 mm and 507.00 mm which was 26.01% more than and 37.79% less than the mean annual rainfall for the past 73 years (1950–2023) (814.99 mm) respectively. The total rainfall during soybean crop growth period of 2022 (27th standard week to 39th standard week) was 494.40 mm in 39 rainy days and higher rainfall received in the 35th standard week. During 2023 (27th standard week to 39th standard week) was 345.61 mm in 22 rainy days and higher rainfall received in the 30th standard week. The weather parameters were optimum for growth and development of crop hence yielded normally. Overall, during the experimental period crop was not subjected to stress.

The Experiment was conducted on vertisol with a P^{H} 7.03, EC 0.123 ds/m, organic carbon content 6.09 g/kg, Available Nitrogen (244.16 kg/ha), Available Phosphorus (43.45 kg/ha) and Available Potassium (353.65 kg/ha) were low, medium and high in range, respectively. The data recorded on various parameters of crop during the course of investigation was statistically analyzed by following the analysis of variance for strip plot design as suggested by Panse and Sukhatme (1985). Statistical significance was tested with 'F' test at 5% level of probability and compared the treatment means with critical difference. Means followed by the same letters do not differ significantly by DMRT at P=0.05.

RESULTS AND DISCUSSION

Seed, Halum yields & Harvest index:

Among the different farming practices, organic farming (OF) recorded higher seed yield and haulm yield on pooled basis (2,977 and 4,808 kg/ha, respectively) than integrated natural farming (INF) (2703 and 3,752 kg/ha, respectively) and natural farming (NF) (2,566 and 3,136 kg per ha, respectively) (Table 1). INF and NF registered 9.20 and 13.80 per cent lower seed yields than OF. The addition of FYM and vermi compost releases the nutrients like N, P, K and enhances growth as it contain several enzymes, plant growth hormones like, cytokinins, gibberlins and vitamins along with micro and macro nutrients (Jaggi *et al.,* 2023). These added nutrients resulted in higher seed yield and halum yields. panchagavya @ 5% application increased 6.43, 10.45, 13.17 and 21.07% seed yield and 5.22, 5.32, 10.10 and 16.24% haulm yield over jeevamrutha, cow urine, vermi wash and control treatments, respectively. *panchagavya* application improves the soil rhizosphere through release of growth enchancing enzymes and leads to mobilization and solubilization of nutrients and made available for the plant uptake (Vinay *et al.,* 2020). Increased plant uptake resulted in enchanced yield attributes and ultimately resulted in yield. This result was ratified with the finding of Aher *et al*. (2019) that, the treatments

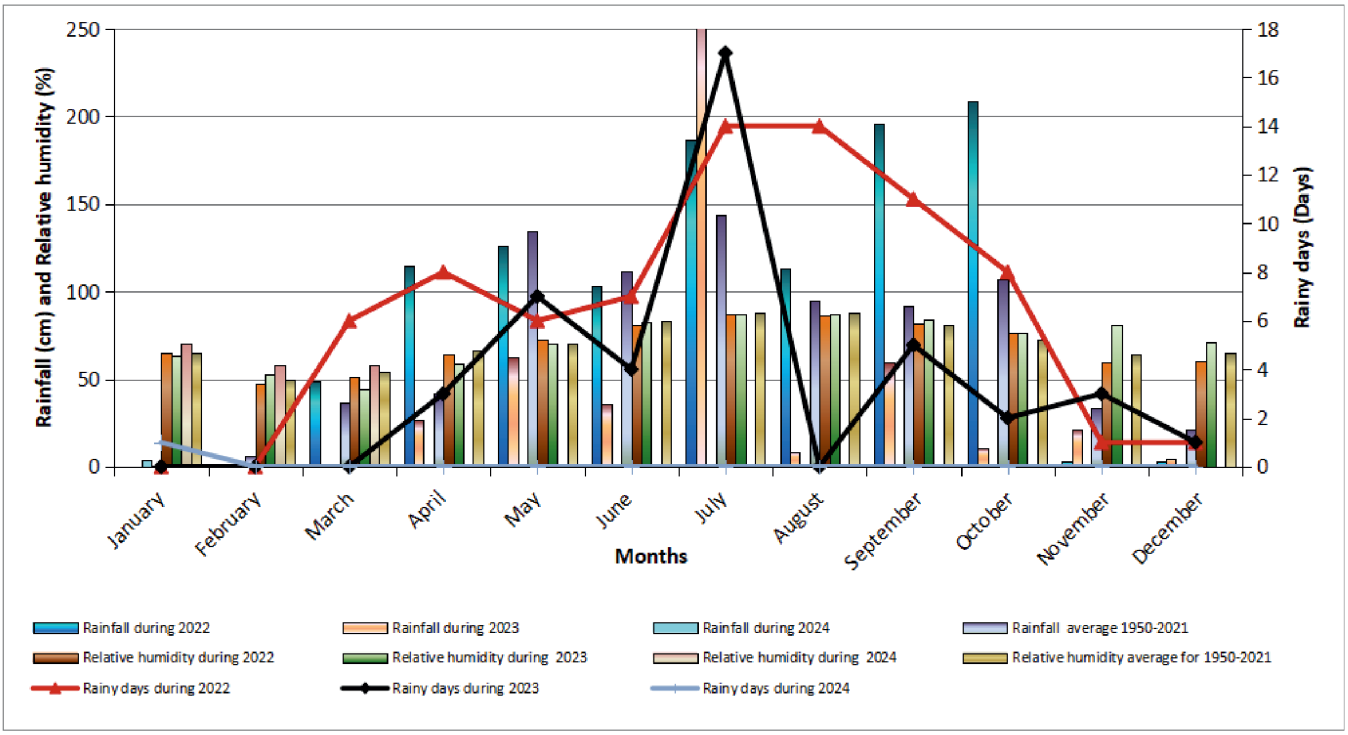

Fig. 1. Weather parameters (Rainfall, relative humidity and rainy days) during crop growing period

Table 1. Seed yield, haulm yield (kg/ha) and harvest index (%) of soybean as influenced by natural, organic and integrated natural farming practices and foliar application of liquid organic manures (pooled data of 2 years)

Treatment: → Farming practices	Seed yield (kg/ha)				(Pooled data) Halum yield (kg/ha)				Harvest index (%)			
↓ LOM's	A_1: NF	A_2: OF	A_3: INF	Mean	A_1: NF	A_2: OF	A_3: INF	Mean	A_1: NF	A_2: OF	A_3: INF	Mean
B_1, Vermiwash @ 10%	2436^{i}	2919^{c}	2619^{h}	2658^{c}	3049^{h}	4502^{b}	3801de	3784^{c}	40.94^{bc}	39.00^{cd}	36.11^{e}	38.69^{b}
B_2, *panchagavya* @ 5%	2884^{c-e}	3250^{a}	3049^{b}	3061^{a}	3448^{e-g}	5180^{a}	3997^{cd}	4209^{a}	42.88^{ab}	38.17^{de}	40.86^{bc}	40.64^{a}
B_3, *Jeevamrutha* @ 20%	2508^{i}	2917^{cd}	2799^{c-g}	2741^{bc}	3199^{f-h}	5094^{a}	3662de	3985^{b}	40.57^{bc}	35.82^{e}	39.17^{cd}	38.52^{b}
B_4, Cow urine @ 10%	2699^{gh}	3043^{b}	2850^{c-f}	2864^{b}	3112^{gh}	5063^{a}	3792de	3989^{b}	43.39^{a}	37.03^{de}	41.23^{abc}	40.55^{a}
B_5, Water spray (control)	2300^{j}	2753^{fg}	2197^{j}	2416^{d}	2871^{h}	4202^{bc}	3507^{ef}	3526^{d}	40.80^{bc}	36.17^{e}	37.47^{de}	38.15^{b}
Mean	2566^{c}	2977^{a}	2703^{b}		3136^{c}	4808^{a}	3752^{b}		41.72^{a}	37.24^{c}	38.97^{b}	
Sources of variation		SEm±		CD (P=0.05)		SEm±		CD (P=0.05)		SEm±		CD (P=0.05)
A		47		130		133		370		0.54		1.50
B		73		168		82		190		0.81		1.86
A × B		51		126		151		370		1.07		2.42
Control:												
C_1, RPP			3322				5281				38.64	
C_2, CF			3116				4898				38.87	
		SEm±		CD (P=0.05)		SEm±		CD (P=0.05)		SEm±		CD (P=0.05)
Control vs interactions		62		179		121		350		0.86		2.51

A_1, Natural farming; A_2, organic farming; A_3, intensification of natural farming with required organic farming practices; C_1, recommended package of practices; C_2, chemical farming
Means followed by the same letters do not differ significantly by DMRT at P=0.05

receiving organic manure along with panchagavya increased soybean seed yield by 9–13% over RDF.

Higher seed yield and haulm yield (3,322 and 5,281 kg/ha) were recorded in RPP than all other treatment combinations. However, the best treatment combination i.e. organic farming with panchagavya @ 5% registered similar values of seed and haulm yields (3,250 and 5,180 kg/ha) as RPP. The organic and natural farming practices resulted in lower yields when compared to recommended package of practices (RPP) because, although organic manures contain nutrients, they are slowly and less readily available to crops, leading to nutrient deficiencies during the early stages of growth (Varsha *et al.*, 2022). In RPP, both combined application of chemical fertilizers and FYM leads to readily available the nutrients for entire crop growth period without shortage (Jaggi *et al.*, 2023). The harvest index values were higher in natural farming than organic farming and integrated natural farming. The harvest index values were higher with panchagavya (40.64%) application and on par with cow urine (40.55%) application. Among the interactions, it was higher with natural farming with cow urine @ 10% (43.39%) when compared to RPP (38.64%) and CF (38.87%).

Economics

Significantly, higher gross returns (GR) were registered with organic farming practices than NF and INF (Table 2). Natural farming (NF) and integrated natural farming (INF) practices recorded 14.5 and 9.6% lesser GR, respectively than compared to organic farming (OF) and 23.3 and 18.9% less compared to recommended package of practices (RPP). This shows that the yield can be increased to the extent of 4.4%. Among the foliar sprays significantly higher returns were with panchagavya application and registered 13.3, 10.3, 6.4 and 20.9% higher than vermiwash, jeevamrutha, cow urine and water spray applications, respectively. Among the interactions, Organic farming with *panchagavya* (A_2B_2) recorded higher gross returns (₹165,479/ha) and it was higher than RPP and CF by 30.2 and 4.0%, respectively. Organic farming with panchagavya application resulted in higher gross returns due to the higher seed yield.

Notably, higher net returns were with natural farming practices. Natural farming and integrated natural farming registered 34.8 and 5.3%, respectively higher net returns when compared to organic farming and 28.1 and 21.8% lesser net returns com-

Table 2. Economics of soybean cultivation as influenced by natural, organic and integrated natural farming practices and foliar application of liquid organic manures (pooled data of 2 years)

Treatment: → Farming practices	Gross returns (₹/ha)				Economics (pooled data) Net returns (₹/ha)				Benefit: cost ratio			
↓ LOM's	A_1: NF	A_2: OF	A_3: INF	Mean	A_1: NF	A_2: OF	A_3: INF	Mean	A_1: NF	A_2: OF	A_3: INF	Mean
B_1, Vermiwash @ 10%	123,213^{h}	148,485^{c}	132,964^{g}	134,887^{c}	86,554^{cd}	65,666^{i}	68,217^{hi}	73,479^{c}	3.36^{d}	1.79^{ij}	2.05^{h}	2.40^{c}
B_2, *panchagavya* @ 5%	145,686^{cd}	165,479^{a}	154,366^{b}	155,177^{a}	10,8931^{a}	82,752^{de}	89,711^{c}	93,798^{a}	3.96^{a}	2.00^{h}	2.39^{f}	2.78^{a}
B_3, *Jeevamrutha* @ 20%	126,839^{h}	148,995^{c}	141,710^{de}	139,181^{c}	90,312^{c}	66,496^{i}	77,283^{fg}	78,030^{c}	3.47^{c}	1.81^{ij}	2.20^{g}	2.49^{c}
B_4, Cow urine @ 10%	136,246^{fg}	155,141^{b}	144,328^{c-e}	145,238^{b}	99,778^{b}	72,702^{gh}	79,960^{ef}	84,147^{b}	3.74^{b}	1.88^{i}	2.24^{g}	2.62^{b}
B_5: Water spray (control)	116,310^{i}	139,999^{ef}	111,862^{i}	122,723^{d}	79,882^{ef}	57,600^{j}	48,334^{k}	61,939^{d}	3.19^{e}	1.70^{j}	1.76^{j}	2.22^{d}
Mean	129,659^{c}	151,620^{a}	137,046^{b}		93,091^{a}	69,043^{b}	72,701^{b}		3.54^{a}	1.84^{c}	2.13^{b}	
Sources of variation	SEm±		CD (P=0.05)		SEm±		CD (P=0.05)		SEm±		CD (P=0.05)	
A	1,856		5,153		1,856		5,153		0.03		0.09	
B	2,222		5,124		2,222		5,124		0.04		0.10	
A × B	2,356		5,679		2,356		5,679		0.05		0.12	
Control:												
C_1, RPP	169,117				130,220				4.35			
C_2, CF	158,584				129,491				5.45			
	SEm±		CD (P=0.05)		SEm±		CD (P=0.05)		SEm±		CD (P=0.05)	
Control vs interactions	2,474		7,127		2,474		7,127		0.06		0.18	

Table 3. Plant nutrient uptake (major nutrients) of soybean cultivation as influenced by different farming practices and foliar application of liquid organic manures

Treatments: Strip I (A: Farming practices) / Strip II (B: Foliar spray of liquid organic manures)	Total nitrogen uptake (kg/ha)				Pooled data of nutrient uptake Total phosphorus uptake (kg/ha)				Total potassium uptake (kg/ha)			
	A_1: NF	A_2: OF	A_3: INF	Mean	A_1: NF	A_2: OF	A_3: INF	Mean	A_1: NF	A_2: OF	A_3: INF	Mean
B_1, Vermiwash @ 10%	177.73^{fg}	230.44^{bc}	190.66^{ef}	199.61^{b}	38.16^{h}	51.94^{c}	43.85^{e}	44.65^{b}	118.70^{g}	152.86^{cd}	148.72^{d}	140.09^{c}
B_2, *panchagavya* @ 5%	205.08^{de}	254.50^{a}	227.84^{bc}	229.14^{a}	43.13^{e}	56.69^{b}	50.38^{c}	50.07^{a}	139.05^{e}	165.13^{b}	156.05^{cd}	153.41^{a}
B_3, *Jeevamrutha* @ 20%	179.32^{fg}	236.34^{b}	204.13^{de}	206.60^{b}	40.76^{fg}	50.43^{c}	46.94^{d}	46.04^{b}	118.57^{g}	166.17^{b}	130.71^{ef}	138.49^{c}
B_4, Cow urine @ 10%	189.16^{ef}	233.59^{b}	207.33^{de}	210.03^{b}	42.24^{ef}	58.83^{a}	48.13^{d}	49.74^{a}	116.58^{g}	185.80^{a}	136.47^{e}	146.28^{b}
B_5, Water spray (control)	162.56^{g}	213.12^{cd}	171.71^{fg}	182.46^{c}	37.50^{h}	50.33^{c}	38.86^{gh}	42.23^{c}	105.12^{h}	159.83^{bc}	123.56^{fg}	129.51^{d}
Mean	182.77^{c}	233.60^{a}	200.33^{b}		40.36^{c}	53.65^{a}	45.63^{b}		119.60^{c}	165.96^{a}	139.10^{b}	
Sources of variations	SEm±		CD (P=0.05)		SEm±		CD (P=0.05)		SEm±		CD (P=0.05)	
A	3.81		10.59		0.42		1.17		3.70		10.26	
B	4.93		11.36		0.77		1.78		2.81		6.48	
A × B	9.16		NS		1.04		2.31		3.73		9.35	
Controls:												
C_1, RPP	264.42				66.71				176.09			
C_2, CF	240.68				59.70				170.46			
	SEm±		CD (P=0.05)		SEm±		CD (P=0.05)		SEm±		CD (P=0.05)	
Control vs interactions	6.49		18.70		0.79		2.26		3.24		9.34	

pared to recommended package of practices (RPP). Among the foliar sprays, vermiwash @ 10%, jeevamrutha @ 20%, cow urine @ 10% and water spray applications registered 21.7, 16.8, 10.3 and 33.9%, respectively lower than panchagavya @ 5% application. Among the interactions, Natural farming with *panchagavya* (A_2B_2) recorded higher gross returns ₹108931 per ha and it was 36.4% lower than RPP and 14.1% higher than CF. Natural farming recorded higher net returns due to less cost involved for the purchase of inputs. Organic farming registered less net returns because of cost involved in the purchase of organic inputs, viz. FYM and vermicompost (70 to 75% of total cost of cultivation). Similarly, less net returns in integrated natural farming in which 50% of the organic inputs applied in the organic farming.

B:C ratio was higher with RPP and followed by CF, NF, INF and OF. A higher B:C ratio was reported by natural farming with panchagavya (A_1B_2) (3.96). Higher net returns in RPP was due to higher seed and halum yields leads to higher net returns and ultimately reflected in B:C ratio than other treatments. Whereas, B:C ratio was higher in NF with panchagavya this was due to less cost incurred in cultivation.

Total nutrient uptake by soybean crop (macro and micro nutrients)

Among the farming practices, the total uptake of nitrogen, phosphorus and potash were recorded to be maximum in organic farming (233.60, 53.65 and 165.96 NPK kg/ha, respectively). Whereas, it was minimum with NF (182.70, 40.36 and 119.60 NPK kg/ha, respectively). Micro nutrients, viz. Iron, zinc and manganese uptakes (83.00, 22.92 and 28.16 g/ha, respectively) were higher with organic farming. Here, the organic sources which increased the protoplasmic constituents and accelerated the process of cell division, cell elongation and extensive root development enhanced more absorption of nutrients like NPK and micro nutrients and ultimately increased plant height and dry matter production. Addition of FYM acted as a buffer in the soil leading to decrease in soil pH, improved physiochemical condition of the soil favourably influencing nutrient uptake thereby increasing yield components (Meena *et al*., 2016).

The total uptake of nitrogen, phosphorus and potash were recorded to be maximum in panchagavya application (229.14, 50.07 and 153.41 NPK kg/ha, respectively). Whereas, it was minimum with water spray (182.46, 42.23 and 129.51 NPK kg/ha, respectively). Micro nutrients like Iron, zinc and manganese uptakes (82.06, 21.60 and 25.70 g/ha, respectively) were higher with panchagavya. Cow urine application also recorded on par values with panchagavya with respect to micro nutrients. The concen-

Table 4. Plant nutrient uptake (micro nutrients) of soybean cultivation as influenced by different farming practices and foliar application of liquid organic manures (pooled data of 2 years)

Treatments: Strip I (A: Farming practices) / Strip II (B: Foliar spray of liquid organic manures)	Pooled data of nutrient uptake: Iron uptake (g/ha)				Zinc uptake (g/ha)				Manganese uptake (g/ha)			
	A_1: NF	A_2: OF	A_3: INF	Mean	A_1: NF	A_2: OF	A_3: INF	Mean	A_1: NF	A_2: OF	A_3: INF	Mean
B_1, Vermiwash @ 10%	72.14^{e}	82.04^{a-c}	75.05^{c-e}	76.41^{b}	16.87^{gh}	22.18^{bc}	18.97^{ef}	19.34^{c}	24.03^{fg}	27.63^{a-d}	18.31^{i}	23.32^{c}
B_2, *panchagavya* @ 5%	79.14^{a-e}	86.01^{a}	81.04^{a-d}	82.06^{a}	18.54^{fg}	24.89^{a}	21.38^{b-d}	21.60^{a}	26.00^{c-f}	29.65^{a}	21.45^{h}	25.70^{a}
B_3, *Jeevamrutha* @ 20%	74.00^{de}	83.05^{ab}	77.00^{b-e}	78.02^{b}	17.04^{gh}	22.68^{bc}	19.65^{d-f}	19.79^{bc}	24.78^{e-g}	28.01^{a-c}	19.45^{hi}	24.08^{bc}
B_4, Cow urine @ 10%	75.00^{c-e}	84.01^{ab}	79.10^{a-e}	79.37^{ab}	17.89^{f-h}	23.14^{b}	20.78^{c-e}	20.60^{ab}	25.45^{d-g}	28.65^{ab}	20.01^{hi}	24.70^{ab}
B_5, Water spray (control)	72.00^{e}	80.00^{a-d}	74.21^{de}	75.40^{b}	16.14^{h}	21.69^{bc}	18.11^{f-h}	18.65^{c}	23.58^{g}	26.88^{b-e}	17.89^{i}	22.78^{c}
Mean	74.46^{b}	83.00^{a}	77.24^{b}		17.30^{c}	22.92^{a}	19.78^{b}		24.77^{b}	28.16^{a}	19.42^{c}	
Sources of variations		SEm±	CD (P=0.05)			SEm±	CD (P=0.05)			SEm±	CD (P=0.05)	
A		1.56	4.33			0.33	0.93			0.46	1.27	
B		1.81	4.18			0.50	1.16			0.59	1.37	
A × B		4.32	NS			0.91	NS			1.04	NS	
Controls:												
C_1, RPP			109.92				31.68				35.00	
C_2, CF			98.02				29.34				28.20	
		SEm±	CD (P=0.05)			SEm±	CD (P=0.05)			SEm±	CD (P=0.05)	
Control vs interactions		2.63	7.57			0.71	2.04			0.82	2.37	

tration of a particular nutrient in soybean was linked with the supply of that particular nutrient from soil to plant. Panchagavya contains cow urine, which act as a source of nitrogen which was readily available in a soluble form to the plant and directly influence the nitrogen content in the leaves. Nutrient accumulation in plants is a function of nutrient content and dry matter accumulation. Increase supply of available plant nutrients with source of foliar application in plant might have increased the accumulation of dry matter affecting the root absorption favourably. Increased dry matter leads to translocation of more carbohydrates towards developing roots. Increased allocation of food materials to roots in turn enhanced the root volume resulted in increased uptake of more plant nutrients. Similar findings observed by Patel *et al*. (2018) in groundnut.

Increased grain & haulm yield resulted with remarkably higher plant N, P and K uptake (264.42, 66.71 and 176.09 kg/ha) were observed in recommended package of practices (RPP) than other treatment interactions. The higher grain yield and halum yield associated with RPP, leads to significantly higher micro nutrients such as higher plant Fe, Zn and Mn (109.92 g/ha), (31.68 g/ha) and (35.00 g/ha) than other treatment combinations in integrated natural, natural and organic farming practices. Soil availability of N, P and K was increased due to mixing of inorganic fertilizer with organic manures that resulted in reduced nitrogen losses and improved fertilizer use efficiency. Among the treatment interactions, best treatment resulted in higher plant N, P and K uptake (254.50, 56.69 and 165.13 kg/ha), plant Fe, Zn and Mn uptake (86.01, 24.89, and 29.65 g/ha), respectively. There was pronounced multiplication of microbes in soil with application of organic manures and biofertilizers. Hence, complex organic anions and hydroxyl acids liberated during the decomposition of organic matter which decreased the phosphate precipitating power of these cations thereby increased the phosphorus and potassium availability. The increased uptake of micro nutrients possibly due to chelating agents like organic acids which are released from organic matter decomposition. This might be reason for the prevention of precipitation, oxidation and leaching of micro nutrients. The application of organic manure along with panchagavya increased the N, P and K uptake in soybean crop by 14%, 20% and 12%, respectively, over RDF (Aher *et al*., 2022). Lunagaria and Zinzala (2017) reported that use of liquid organics improves physical, chemical and biological (population of bacteria, fungi and actinomycetes) properties of soil as well as nutrient uptake and yield of different crops.

During the investigation, it was found that, the stable yields of seed and halum and higher nutrient uptake were observed with organic farming with foliar application of *panchagavya @* 5% in soybean. It was on par with recommended package of practices. However, the net returns and B:C ratios were higher with NF than other treatment combinations.

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