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Response of Soybean (*Glycine max* (L.) Merrill) to foliar applications of different liquid formulations on yield attributing characters, yield and economics

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Abstract

An experiment entitled "Response of soybean to foliar applications of different liquid formulations on yield attributing characters, yield and economics" was conducted at P.G. Research Farm, Agronomy Section, RCSM College of Agriculture, Kolhapur during the *kharif* season of 2022 to evaluate effect of foliar application of liquid formulations on yield attributing characters, yield and economics of soybean. The obtained result showed that the foliar spray of panchgavya (5%) at branching and at flowering stage recorded higher yield attributing characters *viz.*, number of pods plant⁻¹ (67.73), number of seeds pod⁻¹ (2.67), number of seeds plant⁻¹ (177.87), seed weight plant⁻¹ (19.40 g), 100 seed weight (14.43 g), seed yield (31.30 q ha⁻¹), straw yield (40.30 q ha⁻¹) and also in economical parameters *viz.*, gross (₹ 152040 ha⁻¹) & net (₹ 73552 ha⁻¹) monetary returns and B:C ratio (1.94). However, it was found at par with the foliar application treatments containing two sprays of *jeevamruth*, vermiwash and cow urine at branching and at flowering stage.

Keywords: Soybean, foliar application, Panchgavya, *Jeevamruth*, vermiwash, cow urine, yield and economics

Introduction

Soybean, recognized as the "wonder crop," holds significant importance as an oilseed crop and is notably abundant in proteins, containing around 38 to 42% protein content and 18 to 22% oil content rich in unsaturated fatty acids. Due to its cost-effectiveness as a protein source, it is commonly referred to as the "Poor Man's Meat," making it a valuable ingredient in baby food and protein supplements. Panchgavya and *Jeevamruth* are most popular and intensively used organic supplements in the field of organic farming from an ancient Vedic period. These liquid bio-stimulants were upgraded form of ancient science, that are rich in essential macro and micronutrients, beneficial microbes, enzymes and growth regulators required for the healthy growth of plants, also act as a tonic for the plants that boosted the crops yield (Rijal *et al.*, 2021)^[7]. *Panchgavya* is a composite of five components: cow dung, cow urine, ghee, milk, and curd. Collectively, these five elements are termed "Gavya" while their combination is referred to as *Panchgavya*. This formulation can be utilized as a foliar spray, soil drench, and seed treatment (Natarajan, 2002)^[4]. Cow urine boasts disinfectant and prophylactic attributes, contributing to the purification of the environment and enhancement of soil fertility (Pathak and Ram, 2013)^[6]. The Indian agricultural sector has a promising opportunity to transition towards organic farming due to its relatively lower per capita and per hectare consumption of chemical fertilizers and pesticides compared to global averages. Organically cultivated produce, including fruits, vegetables, spices, condiments, crops, medicinal plants, and aromatic plants, exhibits enhanced shelf life compared to conventionally grown counterparts. Hence, it is decided to conduct the field experiment to evaluate response of soybean to foliar application of liquid formulations on growth attributing characters.

Materials and Methods

An agronomic field investigation was carried out during kharif season of 2022 at the P.G. Research Farm, Agronomy Section, RCSM College of Agriculture, Kolhapur. The trial was arranged using a randomized block design, featuring three replications and eleven treatments, consist of absolute control (T₁), spray of cow urine (5%) at branching stage (T₂), spray of cow urine (5%) at branching stage + at flowering stage (T₃), spray of *panchagavya* (5%) at branching stage (T₄), spray of *panchagavya* (5%) at branching stage + at flowering stage (T₅), spray of *jeevamruth* (5%) at branching stage (T₆), spray of *jeevamruth* (5%) at branching stage + at flowering stage (T₇), spray of vermiwash (5%) at branching stage (T₈), spray of vermiwash (5%) at branching stage + at flowering stage (T₉), urea spray (2%) at branching stage (T₁₀), urea spray (2%) at branching stage + at flowering stage (T₁₁). For all the above treatments fertilizer dose is applied as per the recommendation (50:75:45 kg NPK ha⁻¹).

Experiment conducted on gross plot of size 5.4 m × 5.0 m and net plot size 3.6 m × 4.0 m. The soil fertility status of experimental site was medium in organic carbon percentage, low in available nitrogen, very high in available phosphorus, and high in available potassium. The electrical conductivity and pH values were 0.15 dSm⁻¹ (normal-low saline) and 7.52 (neutral), respectively. Application of liquid formulations as per treatment were done as a solution in water at the rate of 500 lit. ha⁻¹ with the help of knapsack sprayer. The various biometric observations on the yield contributing characters of soybean were recorded on five randomly selected plants from each net plot during the course of investigation. Regarding economic parameters viz., cost of cultivation, gross & net monetary returns and B:C were calculated on the net plot basis and then expressed on the hectare basis.

Results and Discussion

A) Effect of different liquid formulations sprays on yield attributing characters of soybean

1. Effect of liquid formulations sprays on mean number of pods plant⁻¹

Treatment containing foliar application of *panchagavya* (5%) at branching stage and at flowering stage recorded maximum number of pods plant⁻¹ i.e. 67.73 which was at par with foliar application treatments including spray of *jeevamruth* (5%) at branching stage + at flowering stage, spray of vermiwash (5%) at branching stage + at flowering stage, spray of cow urine (5%)

at branching stage + at flowering stage and urea spray (2%) at branching stage and urea spray (2%) at branching stage + at flowering stage which was significantly more over rest of treatments. Treatment of absolute control observed lowest number of pods plant⁻¹. The number of pods was significantly increased in treatments containing nutrient spray in both branching and flowering stage. The results of present study are parallel with the earlier reported by Sutar *et al.*, (2019)^[9], Patel *et al.*, (2018)^[5], Chaudhari *et al.*, (2018)^[11] and Sheikh *et al.*, (2018)^[8].

2. Effect of liquid formulations sprays on mean number of seeds pod⁻¹

The data in Table 1 concerning the mean number of seeds pod⁻¹ showed no significant differences in response to the various foliar application treatments. The results of present study are found parallel with the earlier reported by Machhar *et al.*, (2021)^[3] and Patel *et al.*, (2018)^[5].

3. Effect of liquid formulations sprays on mean number of seeds plant⁻¹

The foliar application treatment containing spray of *panchagavya* (5%) at branching stage and at flowering stage which gave the highest number of seeds plant⁻¹, recording 177.87, which was on par with the results obtained from foliar application treatments including spray of *jeevamruth* (5%) at branching stage + at flowering stage and statistically more over rest of the treatments.

4. Effect of liquid formulations sprays on mean seed weight plant⁻¹ (g)

The foliar application treatment containing foliar application of *panchagavya* (5%) at branching stage and at flowering stage gave relatively higher seed weight plant⁻¹, measuring 19.40 grams, and this result was significantly consistent with the outcomes in foliar application treatments including spray of *jeevamruth* (5%) at branching stage + at flowering stage, spray of vermiwash (5%) at branching stage + at flowering stage, spray of cow urine (5%) at branching stage + at flowering stage and urea spray (2%) at branching stage and urea spray (2%) at branching stage + at flowering stage. Treatment of absolute control, in contrast, recorded the lowest seed weight plant⁻¹ that is 15.32 grams. The average seed weight in grams plant⁻¹ exhibited a significant increase in treatments that included nutrient spray during both the branching and flowering stages.

Table 1: Effect of different foliar application of liquid formulations on yield attributing characters of soybean

Treatments	No. of Pods Plant ⁻¹	No. of Seeds Pod ⁻¹	No. of seeds plant ⁻¹	Seed Weight plant ⁻¹ (g)	100 Seed Weight (g)
T ₁ : Absolute control	57.20	2.00	113.27	15.32	12.83
T ₂ : Spray Cow Urine (5%) at Branching Stage	58.00	2.20	127.80	15.57	13.21
T ₃ : Spray Cow Urine (5%) at Branching Stage + At Flowering Stage	63.80	2.40	145.67	18.56	13.76
T ₄ : Spray <i>Panchagavya</i> (5%) at Branching Stage	61.00	2.27	136.07	16.47	13.57
T ₅ : Spray <i>Panchagavya</i> (5%) at Branching Stage + At Flowering Stage	67.73	2.67	77.87	19.40	14.43
T ₆ : Spray <i>Jeevamruth</i> (5%) at Branching Stage	60.47	2.20	133.13	16.38	13.53
T ₇ : Spray <i>Jeevamruth</i> (5%) at Branching Stage + At Flowering Stage	66.80	2.60	175.27	19.15	14.39
T ₈ : Spray Vermiwash (5%) at Branching Stage	60.07	2.20	130.07	15.83	13.21
T ₉ : Spray Vermiwash (5%) at Branching Stage + At Flowering Stage	63.87	2.47	157.00	18.80	14.26
T ₁₀ : Urea Spray (2%) at Branching Stage	57.73	2.13	125.47	15.49	13.12
T ₁₁ : Urea Spray (2%) at Branching Stage + At Flowering Stage	62.27	2.33	145.20	18.44	13.75
S.Em. ±	1.94	0.13	4.54	0.55	0.40
LSD (P = 0.05)	5.72	NS	13.38	1.62	NS
General mean	61.72	2.31	142.42	17.22	13.64

5. Effect of liquid formulations sprays mean 100 Seed Weight (g)

Mean weight of 100 seeds did not exhibit significant differences with the application of various treatments. The treatment with the highest mean weight of 100 seeds was in foliar application of *panchagavya* (5%) at branching stage and at flowering stage *i.e.* 14.43 grams, while the lowest was observed in absolute control treatment *i.e.* 12.83 grams. The results of present study are found parallel with the earlier reported by Machhar *et al.*, (2021) [3].

B) Effect of different liquid formulations sprays on yield of soybean

1. Effect of liquid formulations sprays on seed yield (q ha⁻¹)

Among the treatments the highest seed yield was recorded in foliar application treatment containing two spray of *panchagavya* at flowering and branching stage, which was at par with foliar application treatments including two sprays of vermiwash, *jeevamrutha* and cow urine. Lowest seed yield was recorded in treatment of absolute control containing application of RDF only. These clearly indicates that along with RDF, spray of micronutrients containing formulations play significant role in increasing seed yield. Also, the treatment containing only one spray of *panchagavya*, vermiwash, *jeevamrutha*, cow urine and urea at branching stage does not show significant difference in yield when compared with absolute control treatment. The seed yield witnessed a growth of 7.37% for foliar application treatment containing two spray of *panchagavya* at flowering and branching stage compared to foliar application treatment of

spray of *jeevamrutha* (5%) at branching stage + at flowering stage, followed by incremental increases of 7.44%, 8.91%, 13.90%, 18.69%, 20.57%, 22.55%, 23.91%, 26.67%, and 28.49% over the foliar application treatments.

2. Effect of liquid formulations sprays on straw yield (q ha⁻¹)

Among the treatments, the treatment that included two sprays of *panchagavya* at the flowering and branching stages yielded the highest amount of straw. This result was comparable to the treatments that incorporated two sprays of vermiwash, *jeevamrutha*, cow urine, and urea. On the other hand, the lowest straw yield was observed in treatment of absolute control, which was subjected to the application of only RDF. Furthermore, the treatment that employed only one spray of *panchagavya*, vermiwash, *jeevamrutha*, cow urine, and urea at the branching stage did not demonstrate a notable variation in yield when compared with absolute control treatment. Treatment T₅ resulted in a percentage increase in straw yield of 2.28, 3.06, 5.50, 8.33, 13.20, 15.47, 17.84, 19.58, 21.75 and 22.49 over the rest of the treatments of foliar spray. The results of present study are found in parallel with the earlier reported by Jagdale *et al.*, (2020) [2] and Sutar *et al.*, (2019) [9].

3. Effect of liquid formulations sprays on harvest index

There were no significant variations in the mean harvest index among the treatments, with the mean harvest index remaining at 42.77%. The foliar application treatment of two sprays of *panchagavya* at the flowering and branching stages had the highest harvest index, measuring 43.72%.

Table 2: Effect of different foliar application of liquid formulations on yield of soybean

Treatments	Seed Yield (q ha ⁻¹)	Straw Yield (q ha ⁻¹)	Harvest Index (%)
T ₁ : Absolute control	24.36	32.90	42.54
T ₂ : Spray Cow Urine (5%) at Branching Stage	25.26	33.70	42.84
T ₃ : Spray Cow Urine (5%) at Branching Stage + At Flowering Stage	28.74	38.20	42.93
T ₄ : Spray <i>Panchagavya</i> (5%) at Branching Stage	26.37	35.60	42.55
T ₅ : Spray <i>Panchagavya</i> (5%) at Branching Stage + At Flowering Stage	31.30	40.30	43.72
T ₆ : Spray <i>Jeevamrutha</i> (5%) at Branching Stage	25.96	34.90	42.66
T ₇ : Spray <i>Jeevamrutha</i> (5%) at Branching Stage + At Flowering Stage	29.15	39.40	42.52
T ₈ : Spray Vermiwash (5%) at Branching Stage	25.54	34.20	42.75
T ₉ : Spray Vermiwash (5%) at Branching Stage + At Flowering Stage	29.13	39.10	42.69
T ₁₀ : Urea Spray (2%) at Branching Stage	24.71	33.10	42.74
T ₁₁ : Urea Spray (2%) at Branching Stage + At Flowering Stage	27.48	37.20	42.49
S.Em. ±	0.89	1.14	1.34
LSD (P = 0.05)	2.63	3.37	NS
General mean	27.09	36.24	42.77

C) Effect of different liquid formulations sprays on economics of soybean

Regarding to cost of cultivation, maximum cost required for foliar spray treatment of *panchagavya* (5%) at branching stage + at flowering stage (₹ 78487) while minimum cost required for treatment of absolute control (₹ 74887 ha⁻¹). Gross monetary returns and net monetary returns was maximum for treatment involving the spray of *panchagavya* (5%) at branching stage and at flowering stage, that is ₹ 152040 ha⁻¹ and ₹ 73552 ha⁻¹ respectively. Also, gross monetary returns and net monetary

returns was minimum for treatment of absolute control that is ₹ 118636 ha⁻¹ and ₹ 43748 ha⁻¹ respectively.

As all the yield parameters and yields were found more in case of foliar application of *panchagavya* (5%) at branching stage and at flowering stage, hence which gained maximum amount of gross and net monetary returns and significantly gave more B:C ratio that is 1.94 than all other foliar application treatments. Minimum B:C ratio shown by absolute control treatment which is 1.58. The results of present study are found parallel with the earlier reported by Chaudhari *et al.*, (2018) [11].

Table 3: Effect of different foliar application of liquid formulations on yield of soybean

Treatments	Cost of Cultivation (₹ ha ⁻¹)	GMR (₹ ha ⁻¹)	NMR (₹ ha ⁻¹)	B:C Ratio
T ₁ : Absolute control	74887	118636	43748	1.58
T ₂ : Spray Cow Urine (5%) at Branching Stage	75605	122936	46948	1.62
T ₃ : Spray Cow Urine (5%) at Branching Stage + At Flowering Stage	76987	139844	63356	1.82
T ₄ : Spray <i>Panchagavya</i> (5%) at Branching Stage	76487	128422	51434	1.67
T ₅ : Spray <i>Panchagavya</i> (5%) at Branching Stage + At Flowering Stage	78487	152040	73552	1.94
T ₆ : Spray <i>Jeevamruth</i> (5%) at Branching Stage	76362	126396	49658	1.65
T ₇ : Spray <i>Jeevamruth</i> (5%) at Branching Stage + At Flowering Stage	77987	141970	64580	1.84
T ₈ : Spray Vermiwash (5%) at Branching Stage	75987	124324	47961	1.63
T ₉ : Spray Vermiwash (5%) at Branching Stage + At Flowering Stage	77237	141818	63982	1.83
T ₁₀ : Urea Spray (2%) at Branching Stage	75545	120286	44740	1.59
T ₁₁ : Urea Spray (2%) at Branching Stage + At Flowering Stage	76737	133848	58242	1.77

Conclusion

All yield parameters including number of pods plant⁻¹, number of seeds pod⁻¹, number of seeds plant⁻¹, seed weight plant⁻¹, 100 seed weight, seed yield, straw yield and in case of economics GMR, NMR and B:C ratio shows significantly higher values when treated with foliar spray of *panchagavya* at both the branching and flowering stages in comparison to the other treatments and the values were found comparable with treatments that contained two sprays of *jeevamruth*, vermiwash, cow urine, and urea at both the branching and flowering stages.

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