Original Research Article

INFLUENCE OF DIFFERENT ORGANICS ON GROWTH, YIELD AND ECONOMICS OF SOYBEAN [*Glycine max* (L.)] UNDER RAINFED CONDITION

ABSTRACT

A field experiment was conducted during 2021 to study the influence of different organics on growth, yield and economic soybean [*Glycine max* (L.)] under rainfed condition. The treatment include different foliar nutrition application (F) *viz.*, control (F_1), 4% panchgavya (F_2), 2% novel organic liquid (F_3), 4% seaweed extract (F_4), 4% cow urine (F_5) and 2% vermiwash (F_6) at 30 and 45 DAS and soil application (S) *viz.*, control (S_1) and jeevamrut (S_2)500 l ha^{-1}. Growth parameter *viz.*, plant height, number of branches $plant^{-1}$ and root nodules $plant^{-1}$ shows significant effect by the treatments. Yield parameter *viz.*, number of pods $plant^{-1}$, number of seeds per pod^{-1}, test weight, seed yield and straw yield of soybean were significantly increased by the treatments of different organics.

Key words: Soybean, foliar spray, soil application, seed, straw and yield

INTRODUCTION

Soybean [*Glycine max* (L.)] is an important oil yielding crop having worldwide adaptation. It belongs to the legume family and native to East Asia. It belongs to the family Fabaceae and sub family Papilionaceae. Soybean is known as the "Golden Bean" of the twentieth century. The leading soybean growing countries are USA, Brazil, China, Argentina, and India. In India, soybean occupies an area of about 10.38 million hectares producing 10.94 million tonnes with the productivity of 1050 kg ha^{-1}, whereas in Gujarat it is grown in 0.15 million hectares with the production of 0.12 million tonnes and productivity of 788 kg ha^{-1} (Anonymous, 2020). Panchgavya is an organic product blended with five different cow products, commonly applied to crop plant in organic farming. It acts as growth promoter and immunity booster and also restricts the incidence of common disease. Vermiwash is watery extract of vermicompost, extracted in the presence of rich population of earthworm and contains several enzymes, plant growth hormone, vitamins along with micro and micro and macronutrients which increase the resistance power of crops against various diseases and enhance the growth and productivity of crops (Zambare*et al*. 2008).

The extract of marine macro algae *viz.*, brown, red and green algae is known to have positive effect on growth and yield of crops. The brown algae are the most commonly used seaweeds in agriculture. Cattle urine is a good source of nitrogen, phosphate, potassium, calcium, magnesium, chlorite and sulphate. It contains 95% water, 2.5% urea, 2.5% others (mineral salts, hormones and enzyme). Novel organic liquid nutrient is a product of Navsari Agricultural University which was patented in the year of 2012. It is prepared from banana pseudostem sap.

Jeevamrut also contains enormous amount of microbial load which multiply and enhance N fixation and nutrient mobilization and utilization increase the soil fertility (Palekar, 2006). Jeevamrut contains small amount of macro and micronutrient as well as growth hormone which is helpful to enhancing the growth and yield of crops. Looking into importance of organics as foliar spray and soil application of jeevamrut, a field experiment was conducted to see that effects on growth, yield and economics of soybean under rainfed condition.

MATERIALS AND METHODS

The field experiment was conducted at the College Farm, Navsari Agricultural University, campus Bharuch (South Gujarat Agro Climatic Zone - II) in the Plot No. 12 during the *Kharif*season of 2021. The soil of experimental field was clayey in texture and slightly alkaline in reaction. The soil was low in available N (244 kg ha^{-1}), low in available P_2O_5 (26.2 kg ha^{-1}) and high in available K_2O (330.21 kg ha^{-1}).

The experiment was laid out in Factorial randomized block design with 12 treatment combinations consisting of two factors *i.e.,* foliar nutrition application (F_1- control, F_2- 4% panchgavya at 30 and 45 DAS, F_3- 2% novel organic liquid at 30 and 45 DAS, F_4- 4% seaweed extract at 30 and 45 DAS, F_5- 4% cow urine at 30 and 45 DAS and F_6-2% vermiwash at 30 and 45 DAS) and soil application (S_1- control, S_2-jeevamrut @ 500 l ha^{-1}) were tested in factorial randomized block design with three replication. The entire dose of fertilizer was 30-60-00 N: P_2O_5: K_2O kg ha^{-1}. Soybean variety KDS-344 was sown by the opening of furrow at distance of 45 x 10 cm. Specially prepared jeevamrut solution was applied at the rate of 500 l ha^{-1} along with the application of farm yard manure in treated plots. Applications of different foliar spray as per treatments were applied at 30 and 45 DAS, using 500-liter water $hectare^{-1}$. The data were analyzed statistically by adopting the standard procedure described by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Effect of Foliar nutrition

Growth and Growth Attributes:

The data can be recorded and analyzed (Table 1) for growth and growth attributing characters of soybean. Among the different treatment growth parameters *viz.*, plant height (94.35 cm), number of branches $plant^{-1}$ (8.69) at harvest and no of root nodules $plant^{-1}$ (39.09)at 60 recorded significantly higher in application of 4% seaweed extract at 30 and 45 DAS (F_4). However, it was remained statistically at par with treatment of 4% panchgavya at 30 and 45 DAS (F_2), 2% novel organic liquid at 30 and 45 DAS (F_3) and 2% vermiwash at 30 and 45 DAS (F_6). This could be due to the presence of growth promoting substances such as IAA, GA, Cytokinin, essential plant nutrients and effective microorganisms in panchgavya and seaweed extract, which improves the cell division, cell elongation and chlorophyll content of leaves thus improves the photosynthetic activity and resulted in higher plant height, branches and nodules. Similar results were obtained by Patel *et al*. (2008),Gurusaravanan*et al*. (2010) and Pramanick*et al*. (2013).

Pramanick*et al*. (2013) recorded that the maximum plant height, number of nodules plant^{-1} and number of branches plant^{-1} in greengram with foliar application of 15% *Kappaphycus*-sap + RDF and was statistically at par with 15% *Gracilaria*-sap + RDF treated plot.

Yield Attributes and Yield:

The Table 2 indicated that the number of pods plant^{-1}, number of seeds pod^{-1}, seed yield and stover yield of soybean was influenced by different foliar nutrition practices. Test weight and harvest index found non-significant influence due to different foliar nutrition practices. Significantly higher number of pods plant^{-1} (94.63), number of seeds pod^{-1} (2.78), seed yield (1595 kg ha^{-1}) and stover yield (3062 kg ha^{-1}) were recorded under application of 4% seaweed extract at 30 and 45 DAS (F_4). However, it was remained statistically at par with treatment of 4% panchgavya at 30 and 45 DAS (F_2), 2% novel organic liquid at 30 and 45 DAS (F_3) and 2% vermiwash at 30 and 45 DAS (F_6). The seaweed extracts significantly influence number of pods plant^{-1}, number of seeds pod^{-1}, seed yield and stover yield due to increased supply of almost all essential plant nutrients which provides good vegetative growth thus increased the photosynthetic activity and further, the translocation and accumulation of photosynthates in the economic sinks. The result was in the conformity with the finding of Rathore*et al*. (2009),Zodape*et al*. (2010), Sujatha and Vijayalakhsmi (2013), Pramanick*et al*. (2013) and Akhila*et al*. (2017).

Zodape*et al*. (2010) revealed that the foliar application of *Kappaphycusalvarezii* 10% concentration on greengram recorded significantly highest no of pods plant^{-1} (36.33), no of seeds pod^{-1} (9.87), seed yield plant^{-1} (17.76 g) and 100 seed weight (4.83 g) as compare to control.

Economics:

Table 3 indicated that maximum net realization (65648 ₹ ha^{-1}) with Benefit cost ratio (1.77) earned under application of 4% seaweed extract at 30 and 45 DAS (F_4) followed by application of 4% panchgavya at 30 and 45 DAS (F_2) with net realization (65101 ₹ ha^{-1}) and Benefit cost ratio (1.88), while lowest net realization (47579 ₹ ha^{-1}) observed in control (F_1) with Benefit cost ratio (1.46).

Effect of soil application

Growth and Growth Attributes:

The data can be recorded and analyzed (Table 1) for growth and growth attributing characters of soybean. Among the different treatment growth parameters *viz.,* plant height (95.90 cm), number of branches plant^{-1} (8.84) at harvest and no of root nodules plant^{-1} (40.69)at 60 recorded significantly highest in application of jeevamrut @500 l ha^{-1} (S_2) compare to control (S_1). The increase in plant height and number of branches^{-1} might be due to accumulation of more amounts of nutrients and presence of microbes in the crop Rhizosphere stimulate the vegetative growth of plant which ultimately increased the plant height and number of branches. Similar finding was reported by Patil and Udmale (2016). Increase in root nodules due to jeevamrut soil application which attributed to vigorous plant growth and better translocation of carbohydrates to the developing root nodules.

Patil and Udmale (2016) revealed that an application of FYM + vermicompost (50% each) + jeevamrut 2 times (30 and 45 DAS) in soybean recorded significantly highest plant height (63.21cm) and higher number of branches (8.70) than rest of the treatment.

Yield Attributes and Yield:

The Table 2 indicated that the number of pods plant^{-1}, number of seeds pod^{-1} (2.73), seed yield and stover yield of soybean was influenced by soil application practices. Test weight and harvest index found non-significant influence due to soil application practices. Significantly highest number of pods plant^{-1} (96.71), number of seeds pod^{-1} (2.73), seed yield (1644 kg ha^{-1}) and stover yield (3072 kg ha^{-1}) were recorded under application of jeevamrut @500 l ha^{-1} (S_2) compares to control (S_1). This might be due to jeevamrut contain beneficial microbes in good numbers and act as a medium for their growth which is helpful for promoting crop growth resulting in good yield attributing characters.Similar finding was reported by Patil and Udmale (2016).

Patil and Udmale (2016) revealed that an application of FYM + vermicompost (50% each) + jeevamrut 2 times (30 and 45 DAS) in soybean recorded significantly higher pod plant^{-1} (58.33), pod weight plant^{-1} (27.15 g), number of grains plant^{-1} (163.20) and grain weight plant^{-1} (9.50 g).

Economics:

An appraisal of data given in Table 3 indicated that maximum net realization (71941 ₹ ha^{-1}) with Benefit cost ratio of 2.16 were accrued with treatment of Jeevamrut @ 500 lit ha^{-1} (S_2), whereas the lowest net realization (50464 ₹ ha^{-1}) were obtained in control (S_1).

Interaction effect:

In Table 4 indicated that the number of branches plant^{-1}, number of nodules plant^{-1}, number of pods plant^{-1} and seed yield significantly influenced by interaction effect of foliar nutrition and soil application practices. Significantly higher number of branches plant^{-1} (9.90), number of nodules plant^{-1} (46.30) and no of pods plant^{-1} (107.13) recorded under treatment combination of 4% seaweed extract at 30 and 45 DAS + application of jeevamrut @500 l ha^{-1} (F_4S_2). However, it was remained at par with treatment combinations of F_2S_2, F_3S_2 and F_6S_2.

Significantly higher Seed yield (1745 kg ha^{-1}) recorded under application of 4% seaweed extract at 30 and 45 DAS + application of jeevamrut @500 l ha^{-1} (F_4S_2). However, it was remained at par with treatment combinations of F_6S_2, F_3S_2 and F_2S_2.

Conclusions

On the basis experiment, it can be concluded that soil application of jeevamrut @ 500 lit ha^{-1} should be done prior to sowing of soybean followed by foliar application of 4% seaweed extract or 4% panchgavya or 2% novel organic liquid or 2% vermiwash at 30 and 45 DAS can be done for obtaining profitable yield of soybean crop.

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Table 1: Effect of different organics on plant height (cm) at harvest, number of branches plant^{-1} at harvest and of number of nodules plant^{-1} at 60 DAS of soybean

Treatments	Plant height (cm)	Number of branches plant^{-1}	Number of nodules plant^{-1}
(1) Foliar nutrition (F)			
F_1: Control	77.36	7.25	30.20
F_2: 4% Panchgavya at 30 and 45 DAS	92.84	8.57	38.69
F_3: 2% Novel organic liquid at 30 and 45 DAS	91.53	8.12	37.51
F_4: 4% Seaweed extract at 30 and 45 DAS	94.35	8.69	39.09
F_5: 4% Cow urine at 30 and 45 DAS	81.84	7.75	33.44
F_6: 2% Vermiwash at 30 and 45 DAS	88.08	8.08	36.06
S.Em. ±	3.73	0.25	1.41
CD at 5%	10.82	0.73	4.14
(2) Soil application (S)			
S_1: Control	79.44	7.31	30.97
S_2: Jeevamrut @ 500 lit/ha.	95.90	8.84	40.69
S.Em. ±	2.23	0.15	0.81
CD at 5%	6.48	0.42	2.39
Interaction (F x S)			
S.Em. ±	5.53	0.35	1.99
CD at 5%	NS	1.04	5.86

Table 2: Effect of different organics on number of pods plant^{-1}, number of seeds pod^{-1}, seed yield, stover yield, test weight and of harvest index of soybean

Treatments	Number of pods plant^{-1}	Number of seeds pod^{-1}	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Test weight (g)	Harvest index
(1) Foliar nutrition (F)						
F_1: Control	75.21	2.21	1238	2428	81.59	33.37
F_2: 4% Panchgavya at 30 and 45 DAS	92.28	2.66	1562	2873	88.50	35.40
F_3: 2% Novel organic liquid at 30 and 45 DAS	89.48	2.58	1526	2850	86.81	35.20
F_4: 4% Seaweed extract at 30 and 45 DAS	94.63	2.78	1595	3062	90.70	34.43
F_5: 4% Cow urine at 30 and 45 DAS	84.50	2.36	1374	2602	84.52	34.60
F_6: 2% Vermiwash at 30 and 45 DAS	88.01	2.46	1505	2797	85.71	34.89
S.Em. ±	2.55	0.11	44.96	136.30	3.92	1.09
CD at 5%	7.49	0.34	131.87	399.75	NS	NS
(2) Soil application (S)						
S_1: Control	78.00	2.29	1290	2466	83.20	34.27
S_2: Jeevamrut @ 500 lit/ha.	96.71	2.73	1644	3072	89.41	35.03
S.Em. ±	1.47	0.06	25.96	78.69	2.26	0.63
CD at 5%	4.32	0.19	76.13	230.79	NS	NS
Interaction (F x S)						
S.Em. ±	3.61	0.16	63.58	192.75	5.54	1.55
CD at 5%	10.59	NS	186.49	NS	NS	NS

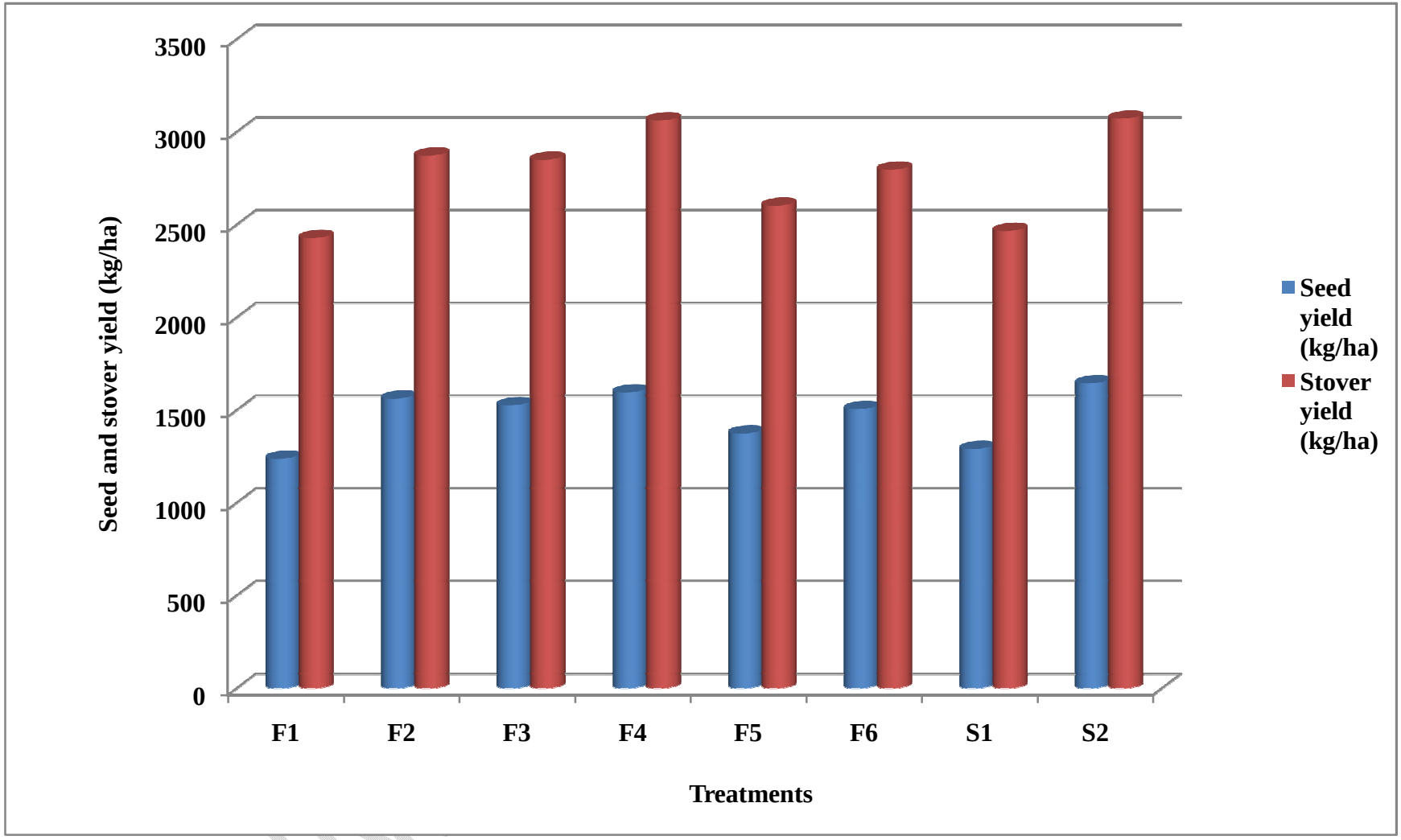

Fig 1: Seed yield (kg ha^{-1}) and stover yield (kg ha^{-1}) of soybean as influenced by different treatments

Table 3: Yield and Economics of soybean as influenced by application of different organics.

Treatments	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Gross return (₹ ha^{-1})	Total cost of cultivation (₹ ha^{-1})	Net return (₹ ha^{-1})	BCR
(1) Foliar nutrition (F)						
F_1: Control	1238	2428	80110	32531	47579	1.46
F_2: 4% Panchgavya at 30 and 45 DAS	1562	2873	99648	34547	65101	1.88
F_3: 2% Novel organic liquid at 30 and 45 DAS	1526	2850	97675	35667	62008	1.74
F_4: 4% Seaweed extract at 30 and 45 DAS	1595	3062	102715	37067	65648	1.77
F_5: 4% Cow urine at 30 and 45 DAS	1374	2602	88215	33467	54748	1.64
F_6: 2% Vermiwash at 30 and 45 DAS	1505	2797	96227.5	33167	63061	1.90
S.Em. ±	44.96	136.30	-	-	-	-
CD at 5%	131.87	399.75	-	-	-	-
(2) Soil application (S)						
S_1: Control	1290	2466	82995	32531	50464	1.55
S_2: Jeevamrut @ 500 lit/ha.	1644	3072	105240	33299	71941	2.16
S.Em. ±	25.96	78.69	-	-	-	-
CD at 5%	76.13	230.79	-	-	-	-
Interaction (F x S)						
S.Em. ±	63.58	192.75	-	-	-	-
CD at 5%	186.49	NS	-	-	-	-

Table 4: F X S interaction effect on number of branches plant^{-1} at harvest, number of nodules plant^{-1} at 60 DAS, number of pods plant^{-1} and seed yield (kg ha^{-1})

Treatments combination	Number of branches plant^{-1}	Number of nodules plant^{-1}	Number of pods plant^{-1}	Seed yield (kg ha^{-1})
F_1S_1	7.17	29.48	74.23	936
F_2S_1	7.41	31.48	79.78	1440
F_3S_1	7.33	31.32	78.59	1434
F_4S_1	7.49	31.88	82.13	1446
F_5S_1	7.20	30.64	75.59	1199
F_6S_1	7.27	31.00	77.65	1285
F_1S_2	7.33	30.92	76.20	1542
F_2S_2	9.74	45.90	104.78	1685
F_3S_2	8.90	43.70	100.37	1619
F_4S_2	9.90	46.30	107.13	1745
F_5S_2	8.31	36.24	93.40	1551
F_6S_2	8.88	41.11	98.36	1725
S.Em. ±	0.36	1.99	3.61	63.58
CD at 5%	1.05	5.86	10.59	186.49