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Effect of organic manures on growth, flowering, enzyme activity and yield of Soybean (*Glycine max l.*) in relation to climate change under mid hill conditions of Uttarakhand

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Abstract

Soybean (*Glycine max* L.) is the leading oil seed crop of the world in term of both area and production. It contributes about 50 per cent of the edible oil production. A pot experiment was conducted during Kharif season at UUHF to study the effect of organic manures on growth , flowering , enzyme activity and yield of Soybean (*Glycine max L.*) in relation to climate change under mid hill condition of Uttarakhand . The experiment was laid out in RBD with three replications. The Vermicompost, B.D and FYM were applied as a basal dose at the time of sowing. Application of Vermicompost, FYM, BD with rhizobium recorded significantly higher plant height (82.40 cm), number of leaves per plant (51.50) and leaf area (391.50 cm^2), dry matter accumulation (22.43 g/plant) and physiological parameters NAR, CGR, RGR, number of pods per plant, number of seeds per pod, test weight, biological yield (55.7 g/plant), grain yield (27.5 g/plant), harvest index in T_4Vermicompost 10t/ha + BD 1t/ha + with rhizobium and lower in T_{11} (FYM – 7.5t/ha + BD 2.5t/ha + Without rhizobium). Organic manures with rhizobium had great influence on Nitrate Reductase activity and Protein content. Significantly higher growth and biochemical parameters were recorded in T_4 and lowest in T_{11}.Where as the results revealed that the basal application of organic manures found to be beneficial in increasing seed yield and yield contributing characters. Meteorological parameters showed a positive effect on growth and yield of Soybean. There was a positive and significant correlation between seed yield and all growth and biochemical parameters.

Keywords: *FYM, Vermicompos, B.D. and Soybean*

Introduction

Soybean (*Glycine max* L.) is the leading oil seed crop of the world in terms of both area and production. It contributes about 50 per cent of the edible oil production. Soybean is one of the principal food crops and has paramount importance in Indian agricultural and oil industry. This crop has remarkably contributed to yellow revolution. At present soybean ranks first among the major oil seed crops both in the world and India. An estimated area of 80.72 million hectare is under soybean cultivation in the world with the production of 196.72 million tones and productivity of 2.34 t/ha (Joshi, 2003). Besides being a major source of high quality cholesterol free edible oil, it is also a rich source of high quality protein. It contain about 30-46 per cent protein. Soybean belonging to family *Leguminaceae*, subfamily *Papilonoideae* and genus *Glycine*, species max is cultivated for oil and protein content. Soybean *(Glycine max*. L) is known as the "Golden bean" of the 20th Century, it is the most important seed crop both in regard to antiquity and used as a source of human food. Soybean is the major oilseed crop in world accounting for nearly 50% of total oilseed acreage as well as production. Soybean has great potential as an exceptionally nutritive and very rich protein food. It can supply the much needed protein to human diets and all essential amino acids particularly glycine, tryptophan and lysine. Legumes are widely recognized to be an impressive symbol of agricultural economy, being a major source of protein in vegetarian human diet and also improve the soil fertility through their nitrogen fixing capability. Pulses contain a high percentage

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of quality protein nearly three times as much as cereals, thus they are cheaper source to overcome protein malnutrition among human beings. Among different legume crops grown in country soybean is an important oilseed as well as a pulse crop. Soybeans are legumes native to East Asia that are grown for oil and protein around the world. Cultivated primarily in warm and hot climates. The use of chemical fertilizers is leading reduction in the crop yield and resulted in imbalance of nutrients in the soil, which has adverse effects on soil health. Use of organic manures (FYM, VC, and BD) alone or combination with chemical fertilizers will help to improve physico-chemical properties of the soils, efficient utilization of applied fertilizers for improving seed yield and seed quality. Organic manures provide a good substrate for the growth of microorganisms and maintain a favorable nutritional balance and soil physical properties. It is recognized that combined source of organic matter and chemical fertilizers play a key role in increasing the productivity of soil. Soybean being a high protein and energy crop and its productivity is often limited by the low availability of essential nutrients or imbalanced nutrition forming one of the important constraints to soybean productivity in India. (Ammitthallingam ,1988). Extensive usage of inorganic fertilizers and pesticides in agriculture has led to environmental problems such as pesticide residues in food commodities, bioaccumulation and biomagnification of pesticides in food chain and loss of soil health. Owing to wide spectral problems with the use of chemical insecticides, organic farming is gaining popularity among the scientists and farming community. Vermicompost and vermiwash (a liquid manure), FYM have been integral part of non-chemical based farming systems such as organic farming, sustainable farming or eco-friendly farming. They in several ways account for crop nourishment, pest resistance processes and soil fertility enhancement (Kale *et al*. 1987, Bhawalkar and Bhawalkar, 1992). Organic manures provide a good substrate for the growth of microorganisms and maintain a favorable nutritional balance and soil physical properties. It is recognized that combined source of organic matter and chemical fertilizers play a key role in increasing the productivity of soil. Soybean being a high protein and energy crop and its productivity is often limited by the low availability of essential nutrients or imbalanced nutrition so organic farming one of the important constraints to soybean productivity in India.

Materials and Methods

The present investigation entitled " effect of organic manures on growth , flowering , enzyme activity and yield of Soybean (*Glycine max L.*) in relation to climate change under mid hill condition of Uttarakhand " was conducted during Kharif season of 2012 and 2013 at Research Farm, UUHF Ranichauri . The experiment was laid out in CRD with three replications. The seeds of Harit Soya variety were sown. The 36 pots of equal size were prepared with the help of different composition of organic composts under 12 treatments i.e. T_{1}- (FYM-20t/ha + with rhizobium), T_2 -(Vermicompost 15t/ha + with rhizobium), T_3 - (FYM – 15t/ha + BD 1t/ha with rhizobium, T_4 - (Vermicompost 10t/ha + BD 1t/ha + with rhizobium ,T_5- (FYM – 7.5t/ha + BD 2.5t/ha +with rhizobium) ,T_6 -(Vermicompost -5t/ha + BD -2.5 t/ha +with rhizobium) ,T_7 -(FYM-20t/ha + with out rhizobium) ,T_8 -(Vermicompost 15t/ha + with out rhizobium), T_9 -(FYM – 15ton/ha + BD 1t/ha with out rhizobium ,T_{10} -(Vermicompost 10t/ha + BD 1t/ha + with out rhizobium , T_{11} -(FYM – 7.5t/ha + BD 2.5t/ha +with out rhizobium) and T_{12} - (Vermicompost -5t/ha + BD -2.5 t/ha +with out rhizobium) The plant height was measured in centimeters with the help of meter rod from the soil level up to the tip of the youngest leaf at 30 days interval. Plant height, number of leaves dry matter and leaf area were measured at 30, 60, 90 days after sowing (DAS) and at harvest. The mean values were used for statistical analysis. Physiological parameters such as relative growth rate (RGR), crop growth rate (CGR), net assimilation rate (NAR) were calculated at different growth stages at 30, 60, 90 days after sowing and at harvest from the plant dry weight as per formula given by Evans in 1972. Chlorophyll content (mg/ml) in leaves was estimated with Dimethyl sulphoxide method by (Hiscox and Israelstam, 1988), Nitrate reductase activity was expressed as micromole nitrate reduced per g fresh weight per hour (Nicholas and Nason, 1957) and protein percent by (A.O.A.C., 1970) method. The various meteorological parameters were recorded during crop season viz, rainfall (cm), temperature , humidity, sun shine hour, wind velocity and soil temperature and correlated with growth parameters, biochemical constituent and yield attributes . The plants of all the plots were harvested and the following parameters were recorded on the plant. Yield and yield components, seed yield per plant, test weight, biological yield, grain yield per pod and harvest index.

Results and Discussion

Morphological parameters like plant height, number of leaves per plant were recorded at 30, 60, 90 DAS and at harvest (Table 1-5). At all the development stages the treatments affected the plant height, number of leaves significantly, which was found to be maximum in T_4 (Vermicompost 10t/ha + BD 1t/ha + with *Rhizobium*) treatment and least in T_{11} (FYM – 7.5t/ha + BD 2.5t/ha +without *Rhizobium)*. Similar results were obtained by (Govindan and Thirumurugan, 2005). Highest dry matter accumulation was found in treatment T_4 (Vermicompost 10t/ha + BD 1t/ha + with *Rhizobium*) as compared with T_{11} (FYM – 7.5t/ha + BD 2.5t/ha +without *Rhizobium*) at all stages of development. Luishuxin *et al.* (1991) reported increased dry weight of soybean plants by 40 to 70 % with the vermicompost. Leaf area showed an increase upto 60 DAS and further decline till harvest. Maximum leaf area was recorded in T_4 (Vermicompost 10t/ha + BD 1t/ha + with *Rhizobium*) followed by T_2(Vermicompost 15t/ha + with *Rhizobium*). Similar results were obtained by (Zou and Zheng (1991).

Table 1: Effect of various levels of organic compost and biofertilizer on plant height (cm), number of leaves per plant at various growth stages.

Treatments	Days after sowing							
	Plant height				Number of leaves			
	30	60	90	At Harvest	30	60	90	At Harvest
T_1 - (FYM-20t/ha + with *Rhizobium*)	40.9	51.8	66.3	68.9	19.2	29.0	36.2	15.1
T_2 -(Vermicompost 15t/ha + with *Rhizobium*)	43.3	52.2	73.5	75.8	25.9	34.1	45.2	16.4
T_3 -(FYM – 15t/ha + BD 1t/ha with *Rhizobium*	41.8	53.2	67.2	71.4	23.2	31.1	39.2	15.2
T_4 -(Vermicompost 10t/ha + BD 1t/ha + with *Rhizobium*	43.4	57.1	74.1	82.4	29.1	39.9	51.50	18.2
T_5 - (FYM – 7.5t/ha + BD 2.5t/ha +with *Rhizobium*)	41.6	51.2	63.8	66.2	22.0	28.1	32.9	14.2
T_6 -(Vermicompost -5t/ha + BD -2.5 t/ha +with *Rhizobium*)	41.9	52.2	72.7	75.2	24.1	32.8	42.8	15.8
T_7 -(FYM-20t/ha + without *Rhizobium*)	40.8	46.1	60.4	62.3	16.1	26.1	33.1	13.2
T_8 -(Vermicompost 15t/ha + without *Rhizobium*)	42.9	51.1	64.5	68.8	22.1	33.0	41.2	13.5
T_9 -(FYM – 15ton/ha + BD 1t/ha without *Rhizobium*	41.3	48.1	62.7	64.1	20.7	29.1	37.4	12.8
T_{10} -(Vermicompost 10t/ha + BD 1t/ha + without *Rhizobium*	42.4	52.1	69.2	72.2	24.1	36.1	45.9	15.9
T_{11} -(FYM – 7.5t/ha + BD 2.5t/ha +without *Rhizobium*)	40.1	44.1	57.4	61.3	19.8	25.1	31.0	11.9
T_{12} -(Vermicompost -5t/ha + BD -2.5 t/ha +without *Rhizobium*)	41.2	49.2	63.1	66.2	20.9	29.9	38.8	12.8
CD at 5%	0.97	1.34	1.56	1.61	0.77	0.53	0.61	0.42

Table 2: Effect of various levels of organic compost and biofertilizer on RGR, NAR CGR at various growth stages.

Treatments	RGR			NAR			CGR		
	30-60	60-90	90-120	30-60	60-90	90-120	30-60	60-90	90-120
T_1- (FYM-20t/ha + with *Rhizobium*)	0.0368	0.0319	0.00168	0.00244	0.00132	0.00069	0.355	0.305	0.205
T_2 -(Vermicompost 15t/ha + with *Rhizobium*)	0.0399	0.0368	0.00195	0.00268	0.00164	0.00086	0.365	0.323	0.215
T_3 -(FYM – 15t/ha + BD 1t/ha with *Rhizobium*	0.0377	0.0327	0.00177	0.00254	0.00139	0.00075	0.359	0.307	0.209
T_4 -(Vermicompost 10t/ha + BD 1t/ha + with *Rhizobium*	0.0419	0.0399	0.00217	0.00275	0.00182	0.00095	0.369	0.335	0.216
T_5- (FYM – 7.5t/ha + BD 2.5t/ha +with *Rhizobium*)	0.0354	0.0317	0.00159	0.00215	0.00120	0.00059	0.349	0.305	0.203
T_6 -(Vermicompost -5t/ha + BD -2.5 t/ha +with *Rhizobium*)	0.0387	0.0352	0.00189	0.00261	0.00145	0.00078	0.360	0.309	0.213
T_7 -(FYM-20t/ha + without*Rhizobium*)	0.0380	0.0308	0.00150	0.00207	0.00115	0.00056	0.329	0.298	0.203
T_8 -(Vermicompost 15t/ha + without*Rhizobium*)	0.0399	0.0327	0.00179	0.00242	0.00144	0.00079	0.343	0.317	0.207
T_9 -(FYM – 15ton/ha + BD 1t/ha without*Rhizobium*	0.0386	0.0318	0.00156	0.00219	0.00125	0.00064	0.329	0.303	0.207
T_{10} -(Vermicompost 10t/ha + BD 1t/ha + without*Rhizobium*	0.0409	0.0335	0.00194	0.00252	0.00165	0.00083	0.355	0.322	0.212
T_{11} -(FYM – 7.5t/ha + BD 2.5t/ha +without*Rhizobium*)	0.0376	0.0307	0.00145	0.00193	0.00104	0.00054	0.325	0.297	0.203
T_{12} -(Vermicompost -5t/ha + BD -2.5 t/ha +without*Rhizobium*)	0.0398	0.0319	0.00165	0.00235	0.00135	0.00073	0.335	0.313	0.208
CD at 5%	0.0003	0.0006	0.0003	0.00042	0.00095	0.00004	0.0037	0.0039	0.0033

Table 3: Effect of various levels of organic compost and biofertilizer on leaf area(cm^2) and dry matter(g) at various growth stages.

Treatments	Leaf area				Dry matter			
	30	60	90	AtHarvest	30	60	90	At harvest
T_1- (FYM-20t/ha + with *Rhizobium*)	164.0	351.2	321.1	226.0	4.85	11.12	14.10	15.90
T_2 -(Vermicompost 15t/ha + with *Rhizobium*)	162.2	367.0	334.0	242.1	5.91	13.18	17.71	18.88
T_3 -(FYM – 15t/ha + BD 1t/ha with *Rhizobium*	166.0	359.2	325.0	231.0	4.97	11.40	15.60	16.86
T_4 -(Vermicompost 10t/ha + BD 1t/ha + with *Rhizobium*	166.0	391.50	352.0	247.2	5.76	15.10	19.20	23.43
T_5- (FYM – 7.5t/ha + BD 2.5t/ha +with *Rhizobium*)	158.0	349.0	317.0	223.8	4.59	11.03	15.32	15.30
T_6 -(Vermicompost -5t/ha + BD -2.5 t/ha +with *Rhizobium*)	159.1	362.2	326.0	230.0	5.19	12.12	16.38	17.32
T_7 -(FYM-20t/ha + without*Rhizobium*)	156.3	343.1	312.0	194.0	4.58	11.20	14.08	15.19
T_8 -(Vermicompost 15t/ha + without*Rhizobium*)	159.2	352.2	326.0	213.0	4.89	12.09	15.95	16.76
T_9 -(FYM – 15ton/ha + BD 1t/ha without*Rhizobium*	161.3	362.2	321.0	201.2	4.65	11.29	14.11	15.25
T_{10} -(Vermicompost 10t/ha + BD 1t/ha + without*Rhizobium*	162.0	372.0	342.0	222.0	5.06	13.11	16.13	17.29
T_{11} -(FYM – 7.5t/ha + BD 2.5t/ha +without*Rhizobium*)	151.3	338.1	301.0	184.1	4.50	11.03	14.00	15.00
T_{12} -(Vermicompost -5t/ha + BD -2.5 t/ha +without*Rhizobium*)	156.1	349.1	316.2	204.0	4.85	11.09	14.65	16.12
CD at 5%	1.94	3.74	3.93	3.74	0.37	0.46	0.45	0.38

Table 4: Effect of various levels of organic compost and bofertilizers on yield and yield contributing characters.

Treatments	Pods/ plant	Average seeds/ plant	Test weight(g/plant)	Grain yield (g/plant)	Biological yield/ plant (g/plant)
T_1(FYM-20t/ha + with *Rhizobium*)	48.3	2.49	151.2	20.11	43.2
T_2(Vermicompost 15t/ha + with *Rhizobium*)	54.3	2.77	172.2	24.20	49.2
T_3(FYM – 15ton/ha + BD 1t/ha with *Rhizobium*)	51.4	2.59	159.2	21.24	45.2
T_4(Vermicompost 10t/ha + BD 1t/ha + with *Rhizobium*	58.2	2.83	176.2	28.5	56.7
T_5(FYM – 7.5t/ha + BD 2.5t/ha +with *Rhizobium*)	46.3	2.49	149.0	18.20	41.2
T_6(Vermicompost -5t/ha + BD -2.5 t/ha +with *Rhizobium*)	52.9	2.69	169.1	23.84	47.2
T_7(FYM-20t/ha + without*Rhizobium*)	43.3	2.39	147.2	15.10	41.8
T_8(Vermicompost 15t/ha + without*Rhizobium*)	47.3	2.45	156.2	17.20	45.2
T_9(FYM – 15t/ha + BD 1t/ha without*Rhizobium*)	45.3	2.41	150.2	15.20	42.2
T_{10}(Vermicompost 10t/ha + BD 1t/ha + without*Rhizobium*)	50.5	2.52	161.2	21.30	49.2
T_{11}(FYM – 7.5t/ha + BD 2.5t/ha +without*Rhizobium*)	41.4	2.39	146.3	14.90	41.1
T_{12}(Vermicompost -5t/ha + BD -2.5 t/ha +without*Rhizobium*)	45.4	2.43	153.1	16.20	42.2
CD at 5%	1.87	0.094	1.24	0.56	0.64

Table 5: Effect of various levels of organic compost and biofertilizer on Chlorophyll content, Nitrate reductase and Protein content (%).

Treatments		Chlorophyll content			Nitrate Reductase		Protein content (%)
	30-60	60-90	90-120	30-60	60-90	90-120	
T_1(FYM-20t/ha + with *Rhizobium*)	10.52	12.19	5.12	0.256	0.313	0.171	41.3
T_2(Vermicompost 15t/ha + with *Rhizobium*)	10.34	14.28	6.09	0.213	0.417	0.231	43.2
T_3(FYM – 15ton/ha + BD 1t/ha with *Rhizobium*)	10.55	12.36	5.33	0.256	0.364	0.182	42.9
T_4(Vermicompost 10t/ha + BD 1t/ha + with *Rhizobium*	10.32	14.88	6.37	0.277	0.429	0.221	44.3
T_5(FYM – 7.5t/ha + BD 2.5t/ha +with *Rhizobium*)	10.48	11.41	4.12	0.262	0.324	0.162	40.4
T_6(Vermicompost -5t/ha + BD -2.5 t/ha +with *Rhizobium*)	10.52	12.77	6.09	0.263	0.342	0.204	43.1
T_7(FYM-20t/ha + without*Rhizobium*)	11.04	11.24	4.58	0.234	0.313	0.132	39.3
T_8(Vermicompost 15t/ha + without*Rhizobium*)	10.37	12.17	4.94	0.239	0.342	0.162	41.2
T_9(FYM – 15t/ha + BD 1t/ha without*Rhizobium*)	9.98	11.33	4.58	0.235	0.323	0.142	40.2
T_{10}(Vermicompost 10t/ha + BD 1t/ha + without*Rhizobium*)	10.49	13.38	4.98	0.241	0.387	0.192	42.3
T_{11}(FYM – 7.5t/ha + BD 2.5t/ha +without*Rhizobium*)	9.56	10.72	4.67	0.223	0.303	0.129	38.8
T_{12}(Vermicompost -5t/ha + BD -2.5 t/ha +without*Rhizobium*)	10.87	12.45	5.34	0.2367	0.349	0.159	40.5
CD at 5%	0.459	0.591	0.368	0.053	0.064	0.078	0.37

Significantly increase in physiological growth parameters viz. RGR, CGR and NAR were obtained during 60-90 DAS.Significantly maximum RGR, CGR and NAR were recorded at 60-90 DAS in T_4 (Vermicompost 10t/ha + BD 1t/ha + with *Rhizobium*) while lowest in T_{11} (FYM – 7.5t/ha + BD 2.5t/ha + without *Rhizobium*). These results are in conformity with those reported by (Watson,1947). Significantly highest chlorophyll content (mg/ml), nitrate reductase activity and protein content (%) was found in all treatments of vermicompost with *Rhizobium* followed by FYM. (Fu *et al.* 2000) Amongst all yield components the number of pods per plants, number of seeds per pod, test weight and biological yield showed positive response to all the treatments, but significantly maximum yield and yield attributes were observed in T_4(Vermicompost 10t/ha + BD 1t/ha + with *Rhizobium*) and minimum in T_{11} (FYM – 7.5t/ha + BD 2.5t/ha +without *Rhizobium*). (Aruna and Narsareddy, 1999) in soybean support these findings.

Conclusion

Extensive usage of inorganic fertilizers and pesticides in agriculture has led to environmental problems such as pesticide residues in food commodities, bioaccumulation and biomagnifications of pesticides in food chain and loss of soil health. So, the present investigation was carried out to examine the entitled " effect of organic manures on growth , flowering , enzyme activity and yield of Soybean (Glycine max L.) in relation to climate change under mid hill condition of Uttarakhand ". Organic manures used in this experiment were FYM, VC and BD. Treatment T_4 consisting of vermicompost and BD were found to be the most effective among all the treatments for enhancing the plant height, number of leaves per plant. Physiological parameters like dry matter accumulation, leaf area, relative growth rate (RGR), crop growth rate (CGR) and net assimilation rate (NAR) was also found to be maximum in the same treatment.Total chlorophyll content, nitrate reductase activity and protein content was maximum in T_4 followed by T_2. Vermicompost proved its superiority over FYM in respect to better morphological, physiological, biochemical parameters and yield and yield contributing characters. All the meteorological parameters were favourable during crop season therefore the better growth, development and yield were recorded in all treatments. Positive correlations were observed in morphological, physiological, yield and yield contributing characters and biochemical parameters with yield of soybean.

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