

Field Bio-Efficacy of Taba-G (Soil Nutrient Catalyzer) and Chemical Fertilizers on Morphological and Yield Contributing Characters in Soybean (*Glycine max. L*)

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ABSTRACT

Soybean (*Glycine max. L.*) is an important crop worldwide because it has a wide of geographical adaptation, good nutritive value, functional health benefits and many end uses. Nutrient management is one of the most important factors in successful cultivation of plants. Bio fertilizers can affect the quality and quantity of crop. Hence, an experiment was conducted to study the effect of TABA-G on soybean yield. TABA-G @ 10.0 kg/ha alone and along with 100% and 75% Recommended Fertilizer Dose (RDF) were evaluated at Agharkar Research Institute's Farm Hol, Pune. Results obtained indicated that two applications of TABA-G @ 10 kg/ha as basal and 30DAS along with RDF significantly increase plant height (17.07%), number of branches/plant (33.60%), pods/plant (23.46%), seeds/pod (14.62%), harvest index (9.67%), 100 seed weight (4.91%), and yield by 16.88% over control and 9.60% over RDF. Likewise, TABA-G along with 75% RDF can also help to increase yield up to 13.03% over control and 5.99% over RDF. Therefore, we can save 25% fertilizer dose for soybean crop for getting yield up to RDF.

Keywords- Soybean, *Glycine max (L)*, TABA-G, soil nutrient catalyzer, soybean yield.

I. INTRODUCTION

Soybean (*Glycine max. L.*Merril) has been considered as an oil seed as well as pulse crop in India. It is an important crop world wide because it has a wide range of geographical adaptation, unique chemical composition, good nutritive value, functional health benefits and versatile end uses. It has good adaptability towards a wide range of soil and climate and fetches good returns to farmers with low level of agricultural inputs. Soils of India are poor in fertility as these are low in organic matter and have consistently been depleted of their nutrient resource due to continuous cultivation for many years. The low and declining soil fertility are the main cause of low productivity of most of the cultivated lands and crops including soybean. In comparison to

India scenario, soybean cultivated soils show wider-spread deficiency of N and P, deficiency of K and S in large pockets and deficiency of Zn and B in small and scattered packets (Singh et. al. 2004). Therefore, there is need to manage these nutrients efficiency so as to obtain sustainable soybean production.

Nutritional management is an important factor in success of any planting crops. Soybean in the case of protein and oil is known as a world's most important crop (Raei et. al. 2008). Through history, legumes have been used for the supply of food, fodder, fuel and traditional medicine (Howjesson et. al., 2008). Protein of soybean seed contains amino acids required for human nutrition and livestock. For optimum plant growth, nutrient must be balanced and should be sufficient for plant or in other words the soil must have nutrients that are needed for plants (Ayoola, 2010). However, most of these resources are in the unavailable form and each year only a little part of them are released through biological activity and chemical processes (Chan, 2006). Hence, in order to increase crop yield per unit area, largely chemical fertilizers are used. The result of these activities in recent years has been the crisis of environmental pollution, especially water and soil pollution that threatens human society.

In long term, sustainable agriculture based on using biological fertilizers is an effective solution for overcoming these problems (Darzi et. al. 2006). Biological fertilizers can affect on yield and quality of product. Mostly biological fertilizers containing useful enzymes and micro-organisms that can increase plant growth and quality of crops, and reduce the cost of fertilizer and pesticide application (Chem, 2006). Phosphate-solubilizing micro-organisms produce various organic acids like oxalate, lactate, acetate, glycolate, gluconate, tartrate, citrate and succinate. Legume families mostly establish symbiotic relationship by rhizobial bacteria and through this symbiosis can fix nitrogen by rhizobial bacteria and provide required nitrogen in this way (Gan and Peoples, 1997). Shaharooha et. al. (2007)

also reported that phosphate-solubilizing bacteria would increase wheat yield. Likewise, Olivera et. al. (2002) reported that the effect of combined inoculation of bean by phosphate solubilizing bacteria and *Bradyrhizobium japonicum* bacteria were positive on dry weight. Stefan et. al. (2010) reported that inoculation of soybean by *Bacillus pumilus* significantly increased plant height, leaf number, leaf area, seed protein and nodulation. While Rosas et. al. (2002) reported that combined inoculation of soybean by symbiotic bacteria of soybean and phosphate solubilizing bacteria improve dry weight of soybean.

Hence, the importance of soybean in production of oil, its nutritional importance and status of biological fertilizers in sustainable agriculture, the study of yield and yield components of soybean affected by biological fertilizer is essential for improvement in yield and quality. Therefore, an experiment was conducted to study the effect of TABA-G a soil nutrient catalyzer on growth and yield contributing characters of soybean.

II. MATERIALS AND METHODS

A field experiment was conducted to study the effect of TABA-G a soil nutrient catalyzer as bio-organic
Treatment Details

agri-inputs for increasing soybean yield and reducing the dosage of chemical fertilizers. Therefore, a study was conducted during 2015-16 kharif season at Agharkar Research Institute's Research Farm, Hol, Taluka Baramati, District Pune, Maharashtra State. The site of the experiment is situated at 18°14 N latitude, 72°21 E longitude and altitude of 548.6 from mean sea level. Soil of the experimental plot was vertisol with slight alkaline pH (7.4). The experiment was laid out in a Randomized Block Design (RBD) with three replications. A promising soybean variety 'MACS-1188' was sown at 45 cm row spacing and 5-7 cm. plant to plant spacing in 5 m X 3.6 m (eight rows) gross plot size. A basal dose of 20:80:20:30 NPKS kg/ha (as per the treatment) was applied at the time of sowing with soil application. Similarly, TABA-G was applied as per the treatment as basal or 30 days after sowing. Protective irrigations were given to all the treatments as per requirement. All the recommended package of practices and agronomic practices were followed to raise a good crop. The Treatment details are given below-

Treatments			
Tr. No.	Product	Dose	Remarks
T ₁	Recommended Dose of Fertilizers (RDF)	20:80:20:30 kg NPKS/ha	Soil application by broadcasting
T ₂	TABA-G Basal	TABA-G 10 kg/ha	Soil application by broadcasting
T ₃	TABA-G - 30 Days After Sowing (DAS)	TABA-G 10 kg/ha	Soil application by broadcasting
T ₄	TABA-G Basal + 30 DAS	TABA-G 5 kg/ha + TABA-G 5 kg/ha	Soil application by broadcasting
T ₅	RDF + TABA G - Basal	20:80:20:30 kg NPK/ha + TABA G 10 kg/ha	Soil application by broadcasting
T ₆	RDF + TABA-G - 30 DAS	20:80:20:30 kg NPK/ha + TABA G 10 kg/ha	Soil application by broadcasting
T ₇	RDF + TABA G - Basal + 30 DAS	20:80:20:30 kg NPK/ha + TABA G 5 kg/ha + TABA G 5 kg/ha	Soil application by broadcasting
T ₈	75% RDF + TABA G - Basal	15:60:15:22.5 kg NPKS/ ha + TABA G 10 kg/ha	Soil application by broadcasting
T ₉	75% RDF + TABA G - 30 DAS	15:60:15:22.5 kg NPKS/ ha + TABA G 10 kg/ha	Soil application by broadcasting
T ₁₀	75% RDF + TABA G - Basal + 30 DAS	15:60:15:22.5 kg NPKS/ ha + TABA G 5 kg/ha + TABA G 5 kg/ha	Soil application by broadcasting
T ₁₁	Control (No RDF)	-	-

TABA-G contains fermented extracts of *Bacillus* spp having nutrient solution of protein hydrolyses, sea weed extract, fermented extract with micronutrients, organic acids with bentonite granules as a carrier material. TABA-G prevents leaching of nutrients

and releases stored nutrients as per the requirements of the soil plots. It works as catalyst between rhizosphere and nutrients available in the soil. It also provides nutrition to soil microbes which brings about increase in the microbial counts and boosts the activity of the

beneficial microbes. It also contains active nutrients which improves the morphological characters of the plants and ultimately yield. Similarly, TABA-G can be used with other granulated chemical fertilizers to improve their efficacy.

Observations were recorded on plant height, number of branches/plant, seeds/pod, harvest index, 100 seed weight and yield kg/ha. Biological yield was recorded on net plot basis and used for calculating the harvest index. Harvest index (%) was calculated as (seed yield/biological yield) x 100. Seed yield was recorded on net plot basis and converted into kg/ha. Data obtained was statistically analysed (ANOVA) according to the method suggested by Panse and Sukhatme (1985).

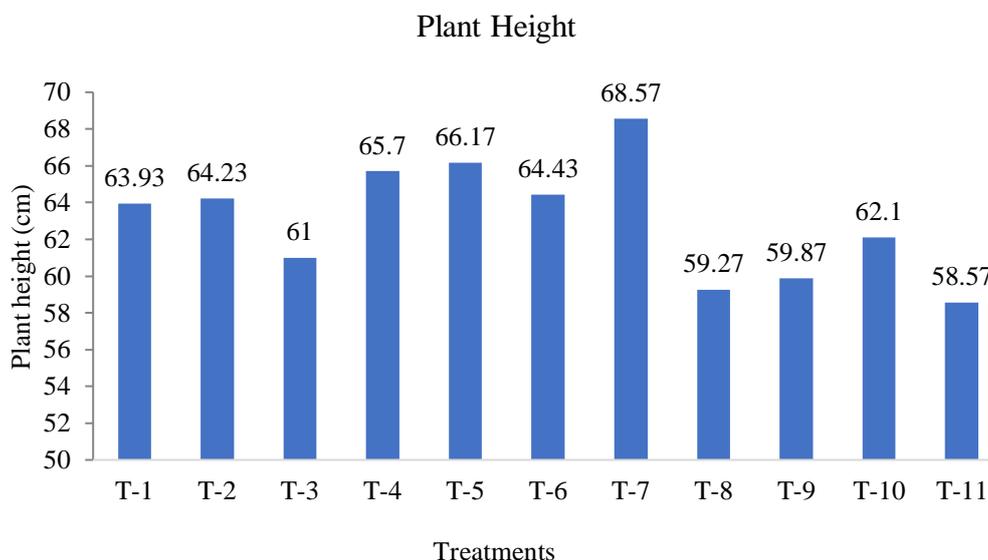
III. RESULTS AND DISCUSSION

Data recorded on seven morphological characters and yield contributing characters are presented

in Table-1 and fig. 1. Results presented in Table-1 indicated that out of 7 seven parameters six parameters are significantly influenced by the application of TABA-G. Significant findings are discussed below-

i) Plant height (cm)

Soil Application of TABA-G influenced very well and statistically significant to the application of different doses individually and in combination with recommended fertilizer dose (RDF). Plant height ranged from 58.57 cm (control) to 68.57 cm (T-7 treatment). Among all the treatments, T-4 (RDF + TABA-G @ 10 kg/ha as basal and 30DAS) treatment recorded statistically significant maximum plant height (68.57 cm) followed by T-5 (66.17 cm), T-7 (65.70 cm), T-6 (64.43 cm), T-2 (64.23 cm) and T-1 (63.93 cm) Treatment. Similarly, T-7 treatment gave significantly more plant height than RDF (63.93 cm) also.



ii) Number of branches/plant

The total no. of branches/plant was counted in each treatment at the time of physiological maturity. No. of branches/plant of soybean varied significantly due to soil application of TABA-G along with RDF. The maximum branches/plant (3.3) was recorded in T-7 (RDF + TABA-G @ 10 kg/ha as basal and 30DAS) treatment followed by T-5 (RDF + TABA-G @ 10 kg/ha Basal) with 3.13 branches/plant which are significantly superior over control. The above two treatments viz. T-7 and T-5 gave 33.60% and 26.13% respectively more branches per plant over control treatment.

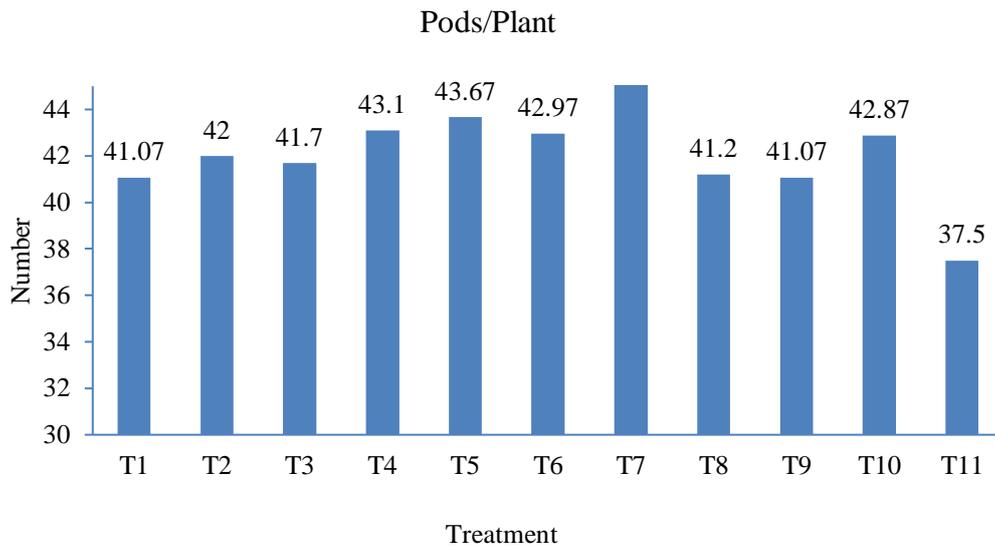
iii) Pods/Plant

No. of pods/plant influenced significantly due to application of TABA-G alone and in combination with 100% RDF. Significantly, maximum pods/plant was recorded in T-7 treatment (46.30) followed by T-5 (43.67), T-4 (43.10) and T-6 (42.97) which are on par

with each other's. T-7 treatment gave 23.46% more pods/plant over control treatment followed by T-5 (16.45%), T-4 (14.93%) and T-6 (14.59) treatment. Even T-7 (RDF + TABA-G @ 10 kg/ha as Basal + 30 DAS) treatment recorded significantly more pods/plant over RDF (T-1) treatment.

iv) Seeds/pod

The data pertaining to the effect of different treatments on seeds/pod significantly influenced (Table-1). The seeds/pod ranges from 2.60 (control T-11) to 2.98 (T-7). Among all the treatments T-7 (RDF + TABA-G as Basal & 30 DAS) recorded significantly maximum seeds/pod (2.98) followed by T-5 (2.93), and T-1, T-4 and T-10 (2.90) treatments which are on par with each other. All the above five treatments gave 14.62% (T-7), 12.69% (T-5) and 11.54% (T-1, T-4 and T-10) more seeds/pod over control treatment.



v) Harvest Index (%)

In regard to harvest index %, all the treatments gave significantly more harvest index over control treatment. However, T-7 (RDF + TABA-G Basal and 30 DAS) gave significantly more harvest index (10.68%) over control treatment followed by T-3 (10.09%), T-6 (9.87%), T-8 (9.67%) and T-1 (9.44%) treatments.

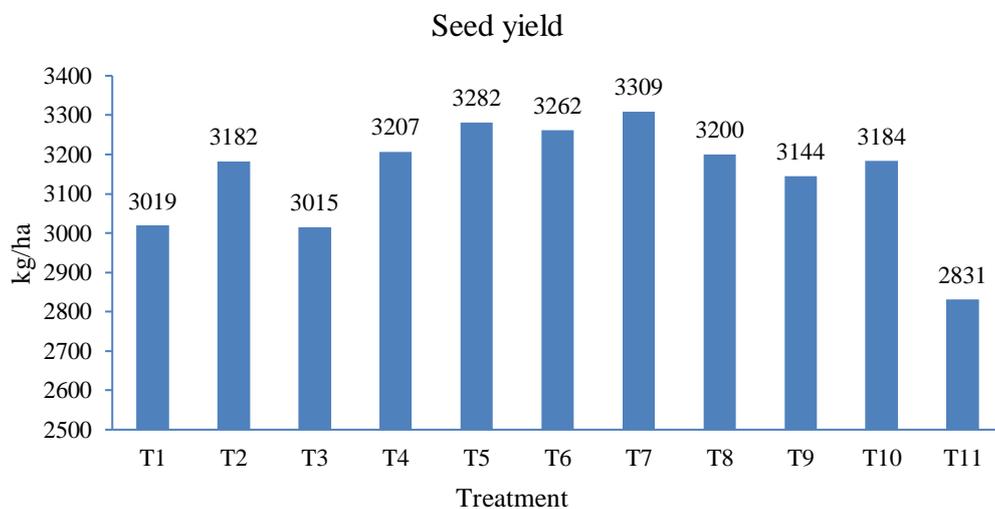
vi) 100 seed weight (g)

The differences for 100 seed weight were non-significant for different doses of TABA-G and RDF individually or in combination with each other. However, T-7 (RDF + TABA-G Basal and 30 DAS) gave higher 100 seed weight (14.30 g) followed by T-4 (TABA-G as Basal and 30DAS) and T-7 (75% RDF + TABA-G as Basal and 30 DAS) with 14.10 g than RDF (13.73 g).

vii) Seed yield (kg/ha)

All the treatments recorded statistically significant variation found due to application of RDF or TABA-G alone or along with each other with different doses which acts as a plant growth promoter in respect of

yield kg/ha of soybean. Seed yield ranges from 2831 kg/ha (T-11 control) to 3309 kg/ha (T-7 - RDF + TABA-G as Basal and 30 DAS) which is 16.88% higher than control treatment. Similarly T-7 treatment (RDF + TABA-G as Basal and 30 DAS) gave significantly higher yield of 3309 kg/ha followed by T-5 (RDF + TABA-G as Basal) with 3282 kg/ha; T-6 (RDF + TABA-G at 30 DAS) with 3262 kg/ha; T-4 (TABA-G as Basal and 30 DAS) with 3200 kg/ha and T-10 (75% RDF + TABA-G as Basal + 30 DAS) with 3184 kg/ha. Likewise, T-7 treatment gave 16.88% higher yield over control treatment followed by T-5 (15.93%) T-6 (15.22%), T-4 (13.28%), T-8 (13.03%) and T-10 (12.46%). All the above six treatments gave significantly more yield than RDF (T-1 treatment). Even T-7, T-5 and T-4 treatments gave 9.60%, 8.71% and 6.22% higher yield than RDF also. Similarly TABA-G along with 75% RDF can also increase yield upto 13.03% over control. Therefore, we can save 25 % fertilizer dose of phosphorous for soybean for getting yield upto RDF.



In the present study, TABA-G contains fermented extract of *Bacillus* spp having nutrient solution of protein hydrolysate, sea weed extract and fermented extract with micronutrient with organic acids resulted in increase of most of the morphological characters and yield. Hence, there was significant increase in plant height (17.07%), branches/plant (33.60%), pods/plant (23.46%), seeds/pod (14.62%), harvest index (9.67%) and yield by 16.88% by using TABA-G along with RDF. Similar results due to

application of TABA-G have been reported by Azizi et. al. (2012), Deotalet. al. (1998), Rahman et. al. (2004), Sarkar et. al. (2014) and Raut et. al. (2014b and 2017) in soybean, Kanitkar et. al. (2013) in Bt. cotton, Raut et. al. (2014a, 2016a) in Tomato, Kumar et. al. (1996) and Raut et. al. (2016c) in okra, Raut et. al. (2015a, 2015b and 2016b) in red gram, Raut et. al. (2015c) in onion, Raut et. al. (2017b) in sugarcane. The present findings are found to be confirmative with above reports.

Table 1: Efficacy of TABA-G in enhancing seed yield of soybean

Tr. No.	Treatments	Plant height (cm)	Branches/plant	Pods/Plant	Seeds/pod	Harvest index (%)	100 seed	seed yield (kg/ha)
T-1	RDF (Full NPKS Dose)	63.93* (9.15)	2.73 (10.53)	41.07 (9.52)	2.90* (11.54)	55.30* (9.44)	13.73 (0.73)	3019* (6.64)
T-2	TABA-G Basal	64.23* (9.66)	3.07 (28.34)	42.00 (12.00)	2.83 (8.85)	55.24* (9.32)	14.07 (3.23)	3182** (12.39)
T-3	TABA-G - 30 DAS	61.00 (4.15)	3.00 (21.45)	41.70 (11.20)	2.83 (8.85)	55.63* (10.09)	14.00 (2.71)	3015* (6.49)
T-4	TABA-G Basal + 30 DAS	65.70* (12.17)	3.07 (24.29)	43.10* (14.93)	2.90* (11.54)	55.16* (9.16)	14.10 (3.45)	3207** (13.28)
T-5	RDF + TABA G - Basal	66.17* (12.97)	3.13* (26.13)	43.67* (16.45)	2.93* (12.69)	55.52* (9.87)	14.03 (2.03)	3282** (15.93)
T-6	RDF + TABA-G - 30 DAS	64.43* (10.01)	3.00 (21.45)	42.97* (14.59)	2.80 (7.69)	55.93* (10.68)	13.90 (1.98)	3262** (15.22)
T-7	RDF + TABA G - Basal + 30 DAS	68.57** (17.07)	3.30* (33.60)	46.30* (23.46)	2.98* (14.62)	55.42* (9.67)	14.30 (4.91)	3309** (16.88)
T-8	75% RDF + TABA G - Basal	59.27 (1.19)	2.63 (6.48)	41.20 (9.86)	2.80 (7.69)	53.42* (5.72)	13.97 (2.49)	3200** (13.03)
T-9	75% RDF + TABA G - 30 DAS	59.87 (2.22)	2.57 (4.05)	41.07 (9.52)	2.83 (8.85)	52.82* (4.53)	13.77 (1.03)	3144* (11.06)
T-10	75% RDF + TABA G - Basal + 30 DAS	62.10 (6.03)	2.73 (10.52)	42.87* (14.32)	2.90* (11.54)	53.10* (5.08)	14.10 (3.45)	3184** (12.46)
T-11	Control	58.57	2.47	37.50	2.60	50.53	13.63	2831
	C.D.at 5%	4.60	0.60	4.86	0.28	1.25	NS	158

Note: () % increase over control; * Significantly superior over control (T-11); **Significantly superior over RDF (T-1)

Plant growth promoting rhizobacteria (PGPR) represent a wide variety of soil bacteria, when grown in association with a host plant, resulted in stimulation of growth of their host. Bio-fertilizers means the use of soil micro-organisms to increase the availability and uptake of mineral nutrients for plant. The main aim of the present study is the mode of action of PGPR which acts as bio-fertilizers, either directly by helping to provide nutrient to the host plant or indirectly by positively influencing root growth and morphology or by aiding other beneficial symbiotic relationships. Many PGPR stimulate the growth of the plants by helping to control pathogenic organism.

Mineral fertilizers and other chemical that commonly used in agricultural production, not only have

harmful effects on the environment, but also they can alter the composition of seeds and fruits (Bogatyre, 2000). Nitrogen is one of the major plant nutrients, being a part of protein, enzymes, amino acids, polypeptides and many other bio-chemical compounds in plant system i.e. encouraging cell division and the development of tissue (Mengel and Kirkby, 1987). Phosphorous plays important roles in most metabolic processes particularly biosynthesis and translocation of carbohydrates. It is very important for developing all organic fruit or seed crops and deficiency of P clearly appeared in terms of decline on the yield and caused an adverse effect on quality of the seeds/fruits (Yagodin, 1990). Potassium is essential in many plant metabolic processes, it plays many important regulatory roles in development (Miller, 1990). Organic

fertilizers instead of mineral fertilizers has become potentially attractive because of the harmful effects and high cost of mineral fertilizers (Darwish et. al. 1995). In addition, the organic minerals improve soil structure, aeration and retention of moisture and reduce soil pH (Nasser, 1988, Raut et. al. 2017). Similarly organic fertilization is another option for supply macro and micro nutrients necessary for plant growth (El-Haggar et. al., 2004). Fertilizing various crops including grapes with organic manures besides the inorganic nitrogen source was accompanied by improving growth and leaf mineral content as well as yield than using nitrogen as an inorganic source only (Mostafa, 2008).

In the present study plant height was increased this is probably due to sufficient supply of required nutrients to the plants, which finally caused the photosynthesis and soybean growth to be improved. These results are in agreement with the results of Darzi et. al. (2006), Raut et. al. (2014b, 2017). Similarly, Dileep Kumar et. al. (2001) also reported that combined inoculation of pea seeds with rhizobial and PSB increased plant height. Increase in the number of branches could be caused by increase in plant growth that was the result of improved nutrient absorption of phosphorus and nitrogen. Nitrogen as part of the protein compounds, enzymes, effective compounds in energy transfer, takes part in structure of DNA, which has direct impact on vegetative growth (Assiouty and Sereda, 2005). The present results obtained showed that the bio-fertilizer TABA-G and chemical fertilizer had a significant effect on number of pods per plant. This result probably was because of balancing uptake of nutrients in root environment, the beneficial effects of these bacteria on enzymes and hormones and their effects on plant growth (Mahfouz and Sharaf-Eldin (2007). However, Gan and Peoples (1997) observed that there was no difference in the number of pods/plant and grain yield between plants inoculated by *B.japonicum* and plants treated by chemical fertilizer.

The no. of seeds/pod differed in various treatments when TABA-G and chemical fertilizers treatment used alone or in combination with each other. This may be due to the hormonal effects of bio-fertilizers and continuous and stable supply of 'P' to the plants during growth and flowering period. Nabila et. al. (2007) observed that application of *Azospirillum* on wheat had significant effect on number of grain per spikelet. Better developed root systems and better absorption of nutrient elements in fertilizer levels may increase 100 seed weight. Improvement of plant nutrition has led to sufficient photo assimilate being transmitted to seeds in the seed filling stage and seeds have more 100 seed weight (Saleh Rastin, 2005). Zhang (2002) reported that soybean seed inoculation with rhizobial bacteria significantly increased 100 seed weight. In the present study, seed yield/ha was significantly increased due to application of bio-fertilizers and chemical fertilizers. Earlier also confirmative results were reported by Raut et. al. (2014b and 2017) on soybean by application of bio-

fertilizers. It seems that nitrogen stabilization and phosphate solubilizing bacteria, by increasing yield component such as no. of pods/plant, seeds/pod, seed number, 100 seed weight increased seed yield. Bacteria used in the present study may be increase seed yield by providing macro and micro nutrients for plant growth, production of stimulate material, development of root system and anti-pathogenic effects (Jat and Ahlawat, 2006).

IV. CONCLUSION

From the present investigation it can be concluded that application of TABA-G @ 10.0 kg/ha individually or along with RDF and 75% RDF significantly increase in morphological and yield contributing characters in soybean. Therefore, application of TABA-G @ 10.0 kg/ha as basal and 30 DAS along with RDF significantly increase in plant height, no. of branches/plant, pods/plant, seeds/pod and yield by 16.88% over control and 9.60% over RDF.

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