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Residual Effects of Chemical Fertilizers, Organic Manure and Biofertilizers Applied to Preceding *Gobhi sarson* Crop on Summer Mung Bean (*Vigna radiata* L.)

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ABSTRACT

Background: Inclusion of legume crops in multiple cropping systems has become crucial to increase the sustainability of agroecosystems. Short duration mung bean can be easily fitted into many cropping sequences which also turns the farming highly remunerative along with strengthening the sustainability. The current study was aimed to evaluate residual effect of nutrient management on performance of summer mung bean in a *gobhi sarson* - summer mung bean sequence.

Methods: During the period of 2016-17 and 2017-18 different doses of chemical fertilizers (NPK), combination of FYM with chemical fertilizers and different biofertilizers alone as well as their combination were evaluated to find out their residual effect on summer mung bean grown after the *gobhi sarson* crop. The data on growth parameters, yield attributes *viz;* plant height, dry matter accumulation, number of branches per plant, number of pods per plant, number of seeds per pod, 100- seed weight were collected. The seed and biological yield from different treatments was also evaluated.

Result: All growth parameters, yield attributes, seed and biological yield of summer mung bean were affected significantly with chemical fertilizers, their combined application with FYM treatments as well as different biofertilizers treatments applied to preceding *gobhi sarson*. Growth and yield significantly improved with each incremental dose of chemical fertilizers *i.e.* from 0 to 50% RDF, 50 to 75% RDF, 75 to 100% RDF while 50% RDF + FYM @ 10 t ha^{-1} being the best treatment. The treatment with consortium showed significantly maximum yield and growth parameters followed by combined application of *Azotobacter* + PSB, PSB alone, *Azotobacter* alone and no inoculation treatments, respectively.

Key words: Biofertilizers, Chemical fertilizers, Consortium, Residual effect FYM, Summer mung bean.

INTRODUCTION

Sustainability of cereal-cereal cropping systems, most prevalent over entire south-east Asia after the advent of green revolution, has been questioned since last two and a half decade due to the depletion of soil fertility and many more reasons (Jat *et al*., 2016). Consequently, inclusion of many alternative crops in the cropping systems has been evaluated and suggestions were made on the basis of those by several researchers. Summer mungbean fits well in many crop sequences owing to availability of short duration varieties, low input requirements and most importantly its leguminous characteristics of increasing the soil fertility.

In Punjab, *gobhi sarson*-summer mung bean sequence for winter and spring season is one of the recommended alternatives of rice-wheat cropping systems (Anonymous, 2020). Currently, a major emphasis is being made on planning the nutrient management strategy based on the entire cropping system rather than focusing on individual crops because succeeding crops are influenced by inputs applied in preceding crops.

Complete reliance on chemical fertilizers not only leads to decline in productivity of the agroecosystems but also incurs high input cost on the farmers. Rather, the use of cheaper and non-harmful sources of nutrients like organic manures and biofertilizers along with chemical fertilizers will bring down the cost of nutrient application and will benefit the succeeding crops due to the carry-over effect. Jamval (2006) reported the increase in nutrient availability of the soil at the harvest of maize due to the application of FYM which positively influenced the yield of succeeding *gobhi sarson* and chickpea.

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MATERIALS AND METHODS

An experiment was conducted at Students' research farm of Punjab Agricultural University, Ludhiana to study the residual effect of biofertilizers, chemical fertilizers and their combination with FYM on summer mung bean under *gobhi sarson*-summer mung bean system. Both the crops were grown in sequence in winter (*rabi*) and spring season,

respectively in two cropping cycles during two consecutive years of 2016-17 and 2017-18. The experimental site is located in North-Western Indo-Gangetic plains. Latitude and longitude coordinates of Ludhiana are: 30.54°N, 75.50°E, respectively. This region is characterized by sub-tropical and semi-arid climate. Soil at Ludhiana was loamy sand, medium in organic carbon (0.43%), low in available nitrogen (231.5 kg ha^{-1}) and potassium (132.7 kg ha^{-1}) and high in available phosphorus (23.8 kg ha^{-1}). The pH and EC of the soil were 7.74 and 0.22 dS m^{-1}, respectively.

The experiment was laid out in split plot design where chemical fertilizers and FYM were applied as main plot treatments and biofertilizers as sub plot treatments to the *gobhi sarson* crop. The main plot treatments included CF_0 - control *i.e.* no chemical fertilizers, CF_1 - 50% RDF (recommended dose of chemical fertilizers), CF_2 - 75% RDF, CF_3 - 100% RDF and CF_4 - 50% RDF + FYM @ 10 t ha^{-1}. The recommended dose of fertilizers (RDF) was based on the soil test done for experimental area. The chemical fertilizers applied were nitrogen in the form of urea, phosphorous in the form of single super phosphate and potassium in the form of muriate of potash. The rate of recommended N, P_2O_5 and K_2O in *gobhi sarson* was 100, 30 and 15 kg ha^{-1}, respectively and for summer mung bean was 12.5 kg ha^{-1} N and 40 kg ha^{-1} P_2O_5. Half of the nitrogen, entire dose of phosphorous and potash was applied before sowing and rest of the half of the nitrogen was applied at first irrigation in *gobhi sarson*. FYM was applied 15 days before sowing in pre marked plots. The sub plot treatments included BF_0 - no inoculation, BF_1 - *Azotobacter*, BF_2 - PSB, BF_3 - *Azotobacter* + PSB and BF_4 - consortium. Consortium is formulated containing *Azotobacter*, PSB and plant growth promoting rhizobacteria (PGPR). Biofertilizers were applied as seed treatment of *gobhi sarson* before sowing at the rate of 500 g ha^{-1} (carrier based formulation containing 2×10^8 cfu/g). Succeeding summer mung bean was sown on the same plots after the harvest of *gobhi sarson*. The chemical fertilizers to summer mung bean were applied uniformly to the entire crop before sowing at recommended rate. The varieties used were "GSC7" of *gobhi sarson* and "SML832" of summer mung bean.

Observations on growth parameters, yield attributes and yield were taken in summer mung bean. Average data of five tagged plants from each plot were used for evaluating plant height, number of branches per plant, number of seeds per pod and 100-seed weight. Seed yield and biological yield were calculated from net plot area and converted into yield per hectare before subjecting to statistical analysis.

The data on each parameter were statistically analysed using technique of analysis of variance following the basic principles as explained by Cochran and Cox (1967) and adapted by Cheema and Singh (1991) in statistical package CPCS-I, software developed by Department of Mathematics, Statistics and Physics, PAU, Ludhiana. The treatment means were compared using 'F' test at 5% level of significance using least significant difference method.

RESULTS AND DISCUSSION

Growth parameters and yield attributes

The data regarding growth parameters and yield attributes of summer mung bean *viz*- plant height and dry matter accumulation at maturity, number of branches per plant, number of pods per plant and 100 seed weight were significantly affected by treatments applied to preceding crop. The maximum plant height was recorded with 50% RDF + FYM @ 10 t ha^{-1} (CF_4) which was also significantly superior to all other doses of chemical fertilizers (Table 1).

Table 1: Residual effect of chemical fertilizers, FYM and biofertilizers on growth parameters of summer mung bean.

Treatment no.	Treatments	Plant height (cm)		Dry matter accumulation (kg ha^{-1})		Number of branches per plant	
		2017	2018	2017	2018	2017	2018
	Chemical fertilizers						
CF_0	Control (0% RDF)	41.8	51.0	2601	2815	2.77	4.37
CF_1	50% RDF	48.2	53.1	3310	3904	4.31	5.65
CF_2	75% RDF	51.1	55.6	3618	4204	5.28	6.91
CF_3	100% RDF	55.0	57.6	3731	4311	5.75	7.77
CF_4	50% RDF + FYM @ 10 t ha^{-1}	60.5	61.9	4124	4688	6.83	9.39
	SEm±	1.5	0.63	71	83	0.17	0.37
	CD (p=0.05)	5.0	2.1	233	271	0.55	1.22
	Biofertilizers						
BF_0	Control (No biofertilizers)	47.9	53.5	3414	3865	4.48	6.17
BF_1	*Azotobacter*	50.3	54.9	3451	3919	4.81	6.65
BF_2	PSB	50.9	54.9	3464	3952	4.87	6.76
BF_3	*Azotobacter* + PSB	53.2	57.5	3506	4074	5.35	7.07
BF_4	Consortium	54.3	58.4	3550	4112	5.44	7.45
	SEm±	1.3	0.61	19	32	0.17	0.21
	CD (p=0.05)	3.7	1.7	54	92	0.49	0.59

Plant height varied from 41.8 cm and 51.0 cm in CF_0 to 60.5 and 61.9 cm in CF_4 during year 2017 and 2018, respectively. Kumpawat (2010) reported significantly higher plant height in mustard at applying 50% RDF + FYM as compared to 100% RDF alone to previous crop of black gram. Among different biofertilizers BF_3 and BF_4 gave significantly higher plant height than single inoculation (BF_1 and BF_2) and no inoculation (BF_0) treatments.

Dry matter accumulation was significantly higher when 50% RDF + FYM @ 10 t ha^{-1} (CF_4) was applied than all other treatments (CF_0, CF_1, CF_2 and CF_3) (Table 2). This treatment had 9.6% more dry matter accumulation on an average during both the years as compared to 100% RDF (CF_3). The residual effect of FYM applied to previous crop of oats on succeeding sorghum crop was also reported by Devi *et al*., 2015. Residual effect of consortium (BF_4) on dry matter accumulation was maximum and significantly superior to single (BF_1 and BF_2) and no inoculation (BF_0) whereas statistically at par with *Azotobacter* + PSB (BF_3). However, single inoculation treatments were numerically better than no inoculation treatment in producing dry matter content of the crop. These findings were similar to those of Deshwal *et al*. (2006) and Devi *et al*. (2015).

Number of branches per plant was higher by 127.2% and 89.4% % in CF_4 treatment as compared to control (CF_0) and 100% RDF (CF_3), respectively (Table 1). Combined application of *Azotobacter* + PSB (BF_3) and consortium (BF_4) produced 16.8% and 21.2% more number of branches per plant respectively as compared to control,.

Number of pods per plant were also significantly influenced by different chemical fertilizer doses with CF_4 being significantly superior to all other treatments and it varied from 12.16 to 25.39 in 2017 and 15.62 to 25.39 in 2018 (Table 2). Among different sub plot treatments *i.e.* biofertilizers, consortium application produced maximum number of pods per plant which was statistically at par with *Azotobacter* + PSB and significantly superior to all other treatments. Similarly, number of seeds per pod were significantly increased with application of FYM along with 50% RDF (CF_4) as compared to all other main plot treatments (Table 2). Number of seeds per pod varied from 9.12 and 9.51 in no biofertilizer (BF_0) treatment to 9.58 and 10.12 in consortium treatment (BF_4) during 2017 and 2018, respectively. 100-seed weight was maximum *(i.e.* 5.3 g) in CF_4 treatment and it was significantly superior to all other treatments (Table 2). Application of consortium *i.e.* BF_4 produced maximum 100 seed weight among different biofertilizers' treatments. Davari *et al*. (2012) reported significant and positive residual effect of FYM and biofertilizers applied to previous crop of rice and wheat on succeeding summer mung bean in terms of yield attributes *i.e.* number of pods per plant, number of seeds per pod and test weight.

Seed and biological yield

The maximum seed yield (962 kg ha^{-1} and 1068 kg ha^{-1}) and biological yield (4590 kg ha^{-1} and 5101 kg ha^{-1}) of summer mung bean was observed through integrated use of 50% RDF + FYM@ 10 t ha^{-1} followed by 100% RDF, 75% RDF, 50% RDF and control, respectively (Table 3). Effect of FYM applied to rice/soyabean on succeeding summer mung bean growth and yield has also been reported by Suryantini (2016). FYM application in oat crop increased dry matter yield and green fodder yield of succeeding sorghum crop due to the improvement in soil physical and chemical properties

Table 2: Residual effect of chemical fertilizers, FYM and biofertilizers on yield attributes of summer mung bean.

Treatment no.	Treatments	Number of pods per plant		Number of seeds per pod		100-seed weight (g)	
		2017	2018	2017	2018	2017	2018
	Chemical fertilizers						
CF_0	Control (0% RDF)	13.79	17.14	8.94	10.00	5.06	5.12
CF_1	50% RDF	19.35	20.55	9.87	10.67	5.17	5.22
CF_2	75% RDF	21.45	22.87	10.34	10.87	5.19	5.25
CF_3	100% RDF	22.79	23.62	10.55	11.10	5.21	5.26
CF_4	50% RDF + FYM @ 10 t ha^{-1}	25.04	26.23	11.14	11.82	5.29	5.32
	SEm±	0.65	0.74	0.16	0.20	0.02	0.01
	CD (p=0.05)	2.11	2.43	0.50	0.66	0.08	0.04
	Biofertilizers						
BF_0	Control (No biofertilizers)	19.97	21.39	9.84	10.31	5.11	5.17
BF_1	*Azotobacter*	20.12	21.65	9.96	10.66	5.15	5.19
BF_2	PSB	20.44	21.88	10.10	10.79	5.15	5.22
BF_3	*Azotobacter* + PSB	20.78	22.50	10.40	11.23	5.23	5.28
BF_4	Consortium	21.10	22.99	10.53	11.47	5.29	5.30
	SEm±	0.21	0.18	0.10	0.17	0.02	0.01
	CD (p=0.05)	0.63	0.52	0.28	0.50	0.06	0.04

Table 3: Residual effect of chemical fertilizers, FYM and biofertilizers on yield (kg ha^{-1}) of summer moong bean.

Treatment no.	Treatments	Seed yield (kg ha^{-1})		Biological yield (kg ha^{-1})	
		2017	2018	2017	2018
	Chemical fertilizers				
CF_0	Control (0% RDF)	665	695	2916	3298
CF_1	50% RDF	779	845	3713	4125
CF_2	75% RDF	840	914	4020	4445
CF_3	100% RDF	889	964	4179	4667
CF_4	50% RDF + FYM @ 10 t ha^{-1}	962	1068	4590	5101
	SEm±	16	17	67	71
	CD (p=0.05)	52	57	220	230
	Biofertilizers				
BF_0	Control (No biofertilizers)	812	878	3790	4169
BF_1	*Azotobacter*	820	891	3830	4258
BF_2	PSB	825	897	3873	4312
BF_3	*Azotobacter* + PSB	833	902	3910	4402
BF_4	Consortium	845	918	4013	4495
	SEm±	7	7	34	53
	CD (p=0.05)	19	21	97	150

and slow releasing of nutrients for long duration (Devi *et al*., 2015). Incontrast, Shivran and Giri (2006) reported significantly higher grain and stalk yield of pigeonpea with residual effect of 100% RDF as compared to 50% RDF and control.

Among different biofertilizers treatments, the maximum seed and biological yield was recorded with consortium application (BF_4) followed by *Azotobacter* + PSB (BF_3). Both of these treatments were significantly superior to single inoculation (BF_1 and BF_2) and no inoculation (BF_0) treatments but statistically at par with each other. However, increase in seed yield varied from 1.05 to 3.43% in single inoculation treatments (BF_1 and BF_2) as compared to no inoculation (BF_0) across both the years. There were no significant interactions between main plot and sub-plot treatments in terms of performance of summer mung bean. PSB and *Azotobacter* positively affect mung bean growth and yield (Walpola and Yoon, 2013; Venkatarao *et al*., 2017; Peter and Satish, 2015; Rani *et al*., 2016).

CONCLUSION

From the analysis of two years of experimental trial, it can be concluded that integrated use of FYM and chemical fertilizers in *gobhi sarson* had significantly higher carry-over effect on succeeding summer mung bean growth and yield. Among different biofertilizers treatments, application of consortium which included all the three bioinoculants *i.e. Azotobacter*, PSB and PGPR had best residual effect on growth and yield of summer mung bean.

Conflict of interest

Authors declare that there is no conflict of interest in the present investigations.

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