Effect of Integrated Nutrient Management on Economics of Summer Mungbean [*Vignaradiata* (L.) Wilczek]

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Abstract: ***Mungbean is an important pulse consumed all over the world, especially in Asian countries, and has a long history of usage as traditional medicine. A field experiment "Effect of Integrated Nutrient Management in Summer Mungbean [Vigna radiata (L.) Wilczek]" was conducted during summer 2020 at agronomy research area of CCS Haryana Agricultural University, Hisar. The treatment comprising twelve fertility level in combination with vermicompost and biofertilizers viz., Control (T1), 50% RDF (T2), 75% RDF (T3), RDF 20 kg N ha and 40 kg P2O5 ha - 1 (T4), 50% RDF + Rhizobium + PSB (T5), 50% RDF + 50% RDN through Vermicompost (T6), 50% RDF + 50% RDN Vermicompost + Rhizobium + PSB (T7), 75% RDF + Rhizobium + PSB (T8), 75% RDF+ 25% RDN through Vermicompost (T9), 75% RDF+ 25% RDN through Vermicompost + Rhizobium + PSB (T10), RDF + Rhizobium + PSB (T11) and 100% RDN Vermicompost Rhizobium + PSB (T12). The experimental trial was conducted in simple Randomize Block Design with three replications. Each replication was divided into twelve equal plots to accommodate the treatments. Based on the research investigation, it was found that integrated nutrient management had significant effect on the seed and biological yield, net monetary returns and benefit - cost ratio of summer mungbean crop. Among the treatment maximum value of these parameters were recorded in the treatment with integration of 75% RDF + 25% RDN through vermicompost + Rhizobium + PSB which in most of the cases was at par with 100% RDN through vermicompost + Rhizobium PSB but significantly superior to rest of the treatments and the minimum success was obtained in control.***

Keywords: Mungbean, INM, *Rhizobium*, PSB, Vermicompost

1. Introduction

Pulses play a significant role in agriculture sector, leads in production and consumption of pulses worldwide. It is a major source of protein for 40% poor and vegetarian people (Avinash and Patil, 2018). Pulses are known for their potential ability of symbiotic nitrogen fixation from atmosphere as they called "mini fertilizer" factory and also known as "marvel of nature" due to deep tap root system that reduces soil erosion and make them tolerant to drought stress (Shrikant, 2010). It is mainly rainy/ *kharif* season crop but can also be grown as an ideal crop under spring and summer seasons because it has low water requirement and capacity to withstand under harsh climate condition. It is favour by patients due to easily digestible and low production of gas (Poehlman, 1991).

At present situation, single source of nutrients like organic matter, chemical fertilizer etc. are not sufficient to produce more crop yield with concern to soil and environmental health. Sole application of organic sources can't maintain and synchronize the required nutrient supply to growing plants due to slow release of lesser quantity of nutrients in time by their mineralization (Akhtar *et a*l., 2011). The use of more and more chemical fertilizers in intensive farming system lead to reduction in soil quality, deterioration of soil and environmental health's through volatilisation, runoff and leaching (Naeem *et al*, 2006), as well as increases the cost of crop production. Bio - fertilizers like *Rhizobium* initially require huge amount of energy for increase their population and activity like nitrogen fixation and solubility of phosphorus in soil. For example, *Rhizobium* inhabiting in its root nodules (Singh and Singh, 2018) require 16 moles of adenosine tri phosphate (ATP) to reduce each mole of nitrogen (Hubbell and Kidder, 2009). INM system technique employs a well - balanced mix of inorganic fertiliser and organic manure to improve soil fertility and crop yield (Kumar *et al*.2013). INM consequences have given way to grow mungbean using various sources of nutrients i. e. inorganic (chemical fertilizers) and organic (Vermicompost) nutrient sources along with bio - fertilizers like *Rhizobium* and PSB. It intended to achieve four major goals *viz*., to maintain soil productivity, to ensure sustainable production, to prevent degradation of the environment and to reduce expenditure on the chemical fertilizers. It not only improves the efficiency but also lowers the quantity of chemical fertilizers required for cultivation and leads to stable crop production and improved availability of major and minor nutrients (Rautaray *et al*., 2003). Therefore, to reduce the losses and indiscriminate use of inorganic fertilizers, substitution with available organic sources of nutrients and bio - fertilizers is inevitable. In order to develop sustainable farming system with reduced use of manufactured fertilizer, more attention need to be given to the use of organic manure that could have beneficial effects on crop production as well as soil health.

2. Literature Survey

Effect of fertility levels:

Jamro *et al.* (2018) revealed that application of 50 kg N and 75 kg P_2O_5 ha $^{-1}$in mungbean were significantly increase the seed yield (2290 kg ha $^{-1}$). Singh *et al.* (2018) found that maximum stover yield and biological yield (2450 and 3944 kg ha $^{-1}$ respectively) were recorded with the application of 60 kg P_2O_5 ha $^{-1}$, which was significantly higher over control and 20 kg P_2O_5 ha $^{-1}$ in chickpea.

Effect of organic manures:

Hussain *et al.* (2017) reported that application of FYM 10 t ha $^{-1}$ produced grain (631 kg ha $^{-1}$) and straw (3759 kg ha $^{-1}$) yield as compared to application of 5 t ha $^{-1}$ (599 kg ha $^{-1}$) in greengram. Yadav *et al.* (2017) investigated an experiment and revealed that treatment of vermicompost[at]2 t ha $^{-1}$ recorded considerably improve the chickpea seed yield (1916 kg ha $^{-1}$) compared to other treatments. Jat *et al.* (2012) revealed that application of FYM in summer greengram enhanced the grain yield by 45.54% (230 kg ha^{-1}) and vermicompost by 62.18% (314 kg ha $^{-1}$) individually over control plot.

Effect of bio - fertilizers:

Kundu *et al.* (2013) results showed that plots treated with *Rhizobium* inoculation seed had a positive and substantial impact on greengram seed and stalk yield. Mir *et al.* (2013) revealed that when blackgram seeds were inoculated with PSB, the grain yield was marginally higher (7.49 q ha $^{-1}$) than when the seeds were not inoculated (7.39 q ha $^{-1}$).

Interaction effects:

Verma *et al.* (2017) revealed that application of 60 kg P_2O_5 ha $^{-1}$ + *Rhizobium* + PSB in greengram gave higher grain yield (1235 kg ha $^{-1}$) and stover yield (2507 kg ha $^{-1}$) as compared to other treatments.

Economics:

Jat *et al.* (2012) conducted an experiment on summer greengram under irrigated conditions in rice - wheat cropping system. They revealed that the combine application of DAP[at]100 kg + vermicompost[at]2 t ha $^{-1}$ and *Rhizobium* culture proved to be the most productive as it gave 1325 kg ha $^{-1}$grain yield and a net profit of 18, 888 Rs. ha $^{-1}$ followed by 100 kg DAP + 5 t FYM ha $^{-1}$ + *Rhizobium* culture (1252 kg ha $^{-1}$grain yield and net profit of 18, 480 Rs. ha $^{-1}$).

3. Materials and Methods

Experiment was conducted **"**To study the effect of integrated nutrient management on yield and economics of summer mungbean" at Experimental area, Agronomy farm, CCSHAU, Hisar, Haryana (India) during summer 2020. Geographically, Hisar is located at 29^0 09' 14.28" North latitute, $75^0$43' 02.84" East longitude and at an altitude of 234 metres above mean sea level. The place falls in western agro - climatic zone IV (Trans Gangetic Plain region).

The soil of the experimental field was loamy sand in texture, alkaline in reaction, poor in organic matter (0.60 kg ha $^{-1}$), low in available nitrogen (116.25 kg ha $^{-1}$) and phosphorus (9.29 kg ha $^{-1}$) and medium in potassium content (242.42 kg ha $^{-1}$). Simple RBD with three replications was used in the trial and each replication contains twelve treatments are discussed above. Recommended dose of fertilizers were N and P applied[at]20 kg ha $^{-1}$ and 40 kg ha $^{-1}$ respectively. The full dose of N and P were given through urea (46% N) and DAP (46% P and 18% N) respectively. The seeds were inoculated with *Rhizobium* and PSB. The vermicompost contained 1.85% N, 0.85% P, and 1.06% K. Application of vermicompost in experimental plot was according to treatment at the time of sowing, in proper calculated amount and with the help of thoroughly mixing of vermcompost in soil. The crop was sown in 2nd fortnight of March using variety MH 421. The requisite plot wise fertilizers were prepared and applied before sowing. Each treatment was accommodated in 6.0 x 3.0 m^2 plots with row to row distance 30 cm and plant to plant 10 cm. Data on yield parameters such as grain and biological yield were recorded as per the standard procedures. The produce obtained under each treatment was multiplied with the prevailing market price of seed and straw to get the gross returns. The cost of cultivation for each treatment was subtracted from the gross returns and net returns were worked out accordingly.

4. Results and Discussion

The significant increase in the yield parameters such as biological yield (36.41 q ha $^{-1}$) and seed yield (11.03 q ha $^{-1}$) was observed with the treatment T_{10} as compared to control and other treatments and was found at par with treatments T_{12} and T_{11}. The application of 75% NPK significantly increased biological yield, grain yield and harvest index of mungbean over control. The combined application of NPK rates to the mungbean increased availability of essential nutrients to plant which improved the plant growth attributes, crop growth rate and ultimately increased yield attributes and parameters through improved supply of the primary macronutrients (NPK). They also help in increasing the availability of essential nutrients to plant that contributes to photosynthesis and the translocation and accumulation of photosynthates in the economic sinks, resulted in increased economical and biological yields. Hossain *et al.* (2021) noticed in a field experiment that application of NPK[at]20 - 50 - 35 kg ha $^{-1}$ results considerable increase in crop yield parameters such as number of pods plant $^{-1}$, number of seeds pod $^{-1}$, 1000 - seed weight, seed and straw yield of mungbean. Kalegore *et al.* (2018) recorded significantly increased straw yield (3881 kg ha $^{-1}$) and seed yield kg ha $^{-1}$ (1564) over the application of 75% RDF in cowpea. Singh *et al.* (2016) found that RDF (25: 50 N: P2O5 kg ha $^{-1}$) significantly increased yield attributes such as number of pods plant $^{-1}$, grain yield, test weight, straw yield, and biological yield, while accompanied a field trial on blackgram.

Application of 25% RDN through vermicompost significantly improve the grain yield plant $^{-1}$ biological yield, grain yield and harvest index of mungbean over control. Vermicompost not only helps to increase soils organic carbon status of but also increase the soil moisture holding capacity. Vermicompost promotes soil flocculation and stabilizes the soil structure. It improves the air - water relationship of soil, thus increasing the water retention

capacity, extensive development of root system of plants and activity of microorganism in soils (resulting in enhanced solubility of nutrients and their consequent availability to plants by reducing soil pH at micro sites, chelating action of organic acids produced by them). Which increase the plant growth and productivity by availability of essential plant nutrients. The increased yield attributes and yield might be due the increased supply of almost all plant essential nutrients by translocation of the photosynthates accumulated under the influence of the sources of organic nutrients. Further, the translocation and accumulation of photosynthates in the economic sinks, resulted in increased grain, straw and biological yields. The mineralization of nutrients is observed to be enhanced. Therefore, it results into boosting up of crop productivity. The vermicomposts have a higher base exchange capacity and more exchangeable calcium, magnesium, potassium than the soil in which worms live. Hussain *et al*. (2017) reported that application of FYM at 10 t ha^{-1} produced higher grain yield (631 kg ha^{-1}) and straw yield (3759 kg ha^{-1}) as compared to application of 5 t ha^{-1} (599 kg ha^{-1}) in greengram. Ranpariya *et al*. (2017) reported that FYM (5t ha^{-1}) significantly increased grain yield (1271 kg ha^{-1}) and straw yield (1645 kg ha^{-1}) in summer mungbean over control (no FYM). Yadav *et al*. (2017) revealed that treatment of vermicompost[at]2 t ha^{-1} recorded considerably improve the chickpea (*Cicer arietinum* L.) haulm yield (2998 kg ha^{-1}) and seed yield (1916 kg ha^{-1}) compared to other treatments.
The biofertilizer inoculation (*Rhizobium* and PSB) significantly improved the yield of summer mungbean over control. The synergistic effect of biofertilizer (*Rhizobium* and PSB) have improved the yield in present study due to increased availability of nitrogen and phosphors in soil through nitrogenase activity and phosphorus solubility by biofertilizer. Similar findings were reported by Kundu *et al*. (2013) showed that plots treated with *Rhizobium* seed inoculation had a positive and substantial impact on greengram seed and stalk yield. Mir *et al*. (2013) revealed that when blackgram seeds were inoculated with phosphorus - solubilizing bacteria (PSB), the grain yield was marginally higher (7.49 q ha^{-1}) than when the seeds were not inoculated (7.39 q ha^{-1}).

The increase in the net returns (NR) and benefit cost ratio (B: C) was observed with the treatment of INM (integrated nutrient management) such as 75% RDF (NPK) + 25% RDN through Vermicompost + biofertilizers (*Rhizobium* and PSB) as compared to other treatments and control (Table 1), which was more as compare to 100% RDN through Vermicompost + biofertilizers (*Rhizobium* and PSB) and100% RDF (NPK) + biofertilizers (*Rhizobium* and PSB). Maximum cost of cultivation was calculated in treatment T_{12} (Rs.48847) and the minimum in control (Rs.43097). The reason behind this may be vermicompost required in large quantity to accomplish the nutrient requirement of crop because it contains small percentage of plant nutrients (1.85% N, 0.85% P_2O_5 and 1% K_2O), which increases the cost of cultivation for the treatment T_{12}. Gross returns were found maximum in T_{10} (75% RDF + 25% RDN through vermicompost + *Rhizobium* and PSB) and minimum was obtained in control (Rs.79395 and Rs.50816 respectively). Maximum grain yield with this treatment combination is the reason for maximum monetary returns. Minimum returns in control treatment were on account of poor grain yield. Net returns were also found maximum in T_{10} (75% RDF + 25% RDN through Vermicompost + *Rhizobium* and PSB) and minimum was obtained in control (Rs.32967 and Rs.7720 respectively). The obtained maximum yield could explain the increased net returns. Better yield might be result in more net returns. Maximum B: C ratio was obtained in T_{10} (1.71) and minimum was obtained in control (1.18). B: C ratio that is income per rupee spent was maximum in treatment combination of 75% RDF + 25% RDN through vermicompost + *Rhizobium* and PSB (1.71). This was due to more net profit than the cost of cultivation in this particular treatment. Similar results have also been Tyagi and Upadhyay (2015) revealed that the application of 100% RDF + FYM[at]2.0 t/ha + *Rhizobium* recorded a net return of Rs.39741 ha^{-1}which was 59.51% higher than control and 5.95% higher than 100% RDF + Rhizobium. Application of 100% RDF + *Rhizobium* provided highest B: C ratio (1.97) followed by 100% + FYM[at]2.0 t/ha + *Rhizobium* (1.94) and control (1.63). Tripathi *et al.* (2014) revealed that the treatment of 50% RDF + 2.5 t FYM + *Rhizobium* + PSB recorded maximum gross returns (Rs.33500 ha^{-1}), net return (Rs.19578 ha^{-1}) and benefit: cost ratio (2.41). Thus, combined application of organic manure, inorganic fertilizer and biofertilizer is found to be most suitable for higher productivity and profitability of grenngram under custard apple based agri - horti system in rainfed condition. Kumar and Kumawat (2014) found higher values of gross return, net return and B: C ratio with the treatment of 75% RDF+ *Azotobacter* + PSB in summer mungbean crop. Jat *et al.* (2012) revealed that the combine application of DAP[at]100 kg + vermicompost[at]2 t ha^{-1} and *Rhizobium* culture in summer greengram proved to be the most productive as it gave 1325 kg ha^{-1}grain yield and a net profit of 18, 888 Rs. ha^{-1} followed by 100 kg DAP + FYM 5 t ha^{-1} + *Rhizobium* culture (1252 kg ha^{-1}seed yield and net profit of 18, 480 Rs. ha^{-1}).

5. Conclusion

According to the above mentioned findings, using the combination of inorganic, organic and bio - fertilisers was more productive than using inorganic fertilisers with bio - fertilisers or organic manure (Vermicompost) with bio - fertilisers. We may be able to lower inorganic fertiliser doses by mixing different source of nutrients. The results show that in the case of MH 421, 75% RDF + 25% RDN through Vermicompost +*Rhizobium* + PSB produced statistically the same yield as RDN through Vermicompost + *Rhizobium* + PSB and 100% RDF + *Rhizobium* + PSB. So, if we use 75% RDF + 25% RDN through Vermicompost +*Rhizobium* + PSB, we will be able to cut consumption of inorganic fertilizer by 25%.

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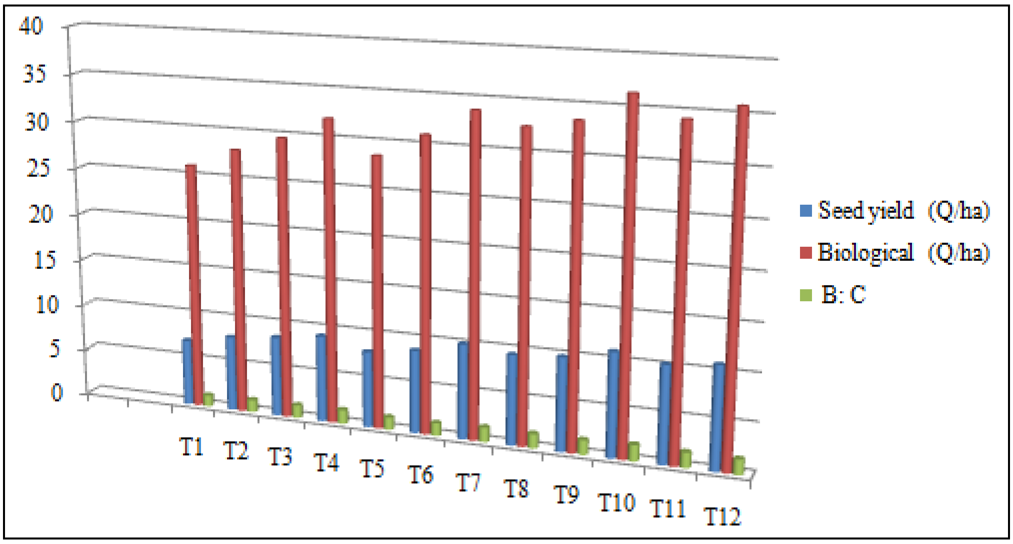

Figure 1: Effect of integrated nutrient management on yield and benefit cost ratio of summer mungbean

Table 1: Effect of integrated nutrient management on yield and economics of summer mungbean

Treatments	Seed yield (q ha^{-1})	Biological yield (q ha^{-1})	Cost of Cultivation ha^{-1} (Rs.)	Gross Returns ha^{-1} (Rs.)	Net Returns ha^{-1} (Rs.)	B: C
T_1 - Control	7.06	26.06	43097	50816	7720	1.18
T_2 - 50% RDF	7.99	28.04	44360	57528	13168	1.30
T_3 - 75% RDF	8.52	29.64	44967	61329	16363	1.36
T_4 - RDF (20 kg N ha^{-1} and 40 kg P_2O_5 ha^{-1})	9.23	31.98	45574	66463	20890	1.46
T_5 - 50% RDF + *Rhizobium* + PSB	8.1	28.59	44409	58344	13935	1.31
T_6 - 50% RDF + 50% RDN through Vermicompost	8.83	31.03	47185	63595	16409	1.35
T_7 - 50% RDF + 50% RDN Vermicompost + *Rhizobium* + PSB	10.08	33.81	47235	72570	25335	1.54
T_8 - 75% RDF + *Rhizobium* + PSB	9.55	32.55	45016	68787	23771	1.53
T_9 - 75% RDF + 25% RDN through Vermicompost	9.9	33.48	46379	71304	24925	1.54
T_{10} - 75% RDF + 25% RDN through Vermicompost +*Rhizobium* + PSB	11.03	36.41	46429	79395	32967	1.71
T_{11} - RDF + *Rhizobium* + PSB	10.31	34.27	45623	74224	28601	1.63
T_{12} - RDN Vermicompost + *Rhizobium* + PSB	10.88	35.82	48847	78338	29491	1.60
SE (m) ±	0.6	1.69	-	-	-	-
CD (5%)	1.75	4.96	-	-	-	-