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Response of INM in Maize – Pulse Intercropping System on Yield and Economics of Maize (*Zea mays* L.)

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ABSTRACT

Field investigation was conducted during *Kharif* season (June to Oct. 2019) to explore the Maize – pulse intercropping system. The experiment was laid out in Randomized Block Design consists of seven treatments viz., T_1 - Sole maize, T_2 - Sole maize + Vermicompost @ 5 t ha^{-1} + eM Power @ 12.5 kg ha^{-1}, T_3 - Sole maize + Poultry manure @ 6 t ha^{-1} + eM Power @ 12.5 kg ha^{-1}, T_4 - Maize + Black gram + Vermicompost @ 5 t ha^{-1} + eM Power @ 12.5 kg ha^{-1}, T_5 – Maize + Black gram + Poultry manure @ 6 t ha^{-1} + eM Power @ 12.5 kg ha^{-1}, T_6 – Maize + Green gram + Vermicompost @ 5 t ha^{-1} + eM Power @ 12.5 kg ha^{-1}, T_7 - Maize + Green gram + Poultry manure @ 6 t ha^{-1} + eM Power @ 12.5 kg ha^{-1} with three replication. The Maize "Co-1" was sown with a spacing of 60 × 20 cm with duration 105 days. The intercrop, Black gram "ADT-3", Green gram "ADT-3" were sown with a spacing of 30 × 10 cm. The yield attributes, TMEY and BCR of maize were favourably influenced by the treatments. The treatment, T_4 - Maize + Black gram + Vermicompost @ 5 t ha^{-1} + eM Power @ 12.5 kg ha^{-1} recorded the higher cob length, number of grains cob^{-1}, Total Maize Equivalent Yield (TMEY) and B:C ratio.

***Key words*:** Maize, Black gram, Green gram, Vermicompost, eM Power

Maize being a C4 plant is an efficient converter of absorbed nutrients into food. Maize is also called as "queen of cereals" or "miracle crop" by virtue of its immense yield potential and wider adoptability. It is an important indispensable ingredient in many fancy dishes and fast-food preparations. Its delicate sweet flavour and crispness made popularity among city elite and middle-class people. Maize is also harvested as young, fresh, sweet and tender babies for vegetable purpose [1]. Strong upward trend in the import of pulses is a cause of concern, since an increase in demand from India has shown to have cascading effect on international prices, thus draining the precious foreign exchange [2]. Over reliance on use of chemical fertilizers has been associated with declines in soil physical and chemical properties and crop yield and significant land problems, such as soil degradation due to over exploitation of land and soil pollution caused by high application rates of fertilizers and pesticide application [3]. The productivity of maize is largely dependent on its nutrient management. It is well known that maize is a heavy feeder of nutrients. Chemical fertilizers cannot be avoided since they are the potential sources of high amount of nutrients in easily available forms.

Growing of legumes like green gram, black gram that constituted as potential intercrops, that ensured more efficient use of land, greater yield stability, diversity of produce and market opportunities [4]. The intercropping system offer a means of promoting diversity of diet, stability of production reduced pests incidence, efficient use of labour, intensification of production with limited source and also maximization of returns [5]. The practice of intercropping is of prime significance where in the total productivity of the system could be enhanced with reduced risk which favours small and marginal farmers. Through increased addition of crop residues, the intercropping system also provides enhanced soil biological activity, nutrient availability and residual soil fertility. Productivity of the systems can be enhanced by optimizing crop geometry, judicious selection of intercrops differing in duration, canopy architecture and growth rhythms so as to adjust the demand of above and below ground resources like light, moisture and nutrients during different growth stages. Vermicompost are organic materials broken down by

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interactions between micro-organism and earthworms in a mesophilic process, to produce fully stabilized organic soil amendments with low C: N ratios [6].

Improved intercropping systems offers the possibility of field stability by increasing yield per unit area of land on a limited amount of land, reducing risk of total crop failure, reduction in farm inputs especially pesticides, herbicides, inorganic fertilizers and increased labour utilization efficiency and provides diversified needs of the small farmers, yet research on maize based intercropping systems.

MATERIALS AND METHODS

The field experiment was conducted in Experimental Farm, Annamalai University, Annamalai Nagar. The Experimental Farm is geographically situated at 11°24´ North latitude and 79°44´ East longitude and at an altitude of +5.79 m above mean sea level, during the *Kharif* season (June to Oct. 2019) to study the response of INM in maize – pulse intercropping system on yield and economics of maize The study area has mean annual rainfall of about 1500 mm, majority of which was received during North East Monsoon. The soil was clayey soil with pH of 7.7. The experiment was laid out in randomized block design with three replications with seven treatments viz., T_1 - Sole maize, T_2 - Sole maize + Vermicompost @ 5 t ha^{-1} + eM Power @ 12.5 kg ha^{-1}, T_3 - Sole maize + Poultry manure @ 6 t ha^{-1} + eM Power @ 12.5 kg ha^{-1}, T_4 - Maize + Black gram + Vermicompost @ 5 t ha^{-1} + eM Power @ 12.5 kg ha^{-1}, T_5 - Maize + Black gram + Poultry manure @ 6 t ha^{-1} + eM Power @ 12.5 kg ha^{-1}, T_6 – Maize + Green gram + Vermicompost @ 5 t ha^{-1} + eM Power @ 12.5 kg ha^{-1}, T_7 - Maize + Green gram + Poultry manure @ 6 t ha^{-1} + eM Power @ 12.5 kg ha^{-1} with three replication. The Maize variety "Co-1" were sown with a spacing of 60 × 20 cm. The intercrop, black gram and green gram "ADT-3" were sown with a spacing of 30 × 10 cm. The observations of yield attributes and yield were recorded.

Recommended fertilizer dose of 135:62.5:50 kg ha^{-1} of N, P_2O_5 and K_2O was applied to the main crop of maize and 25:50:25 kg ha^{-1} of N, P_2O_5 and K_2O was applied to the pulse intercrop plot. Half of the recommended nitrogen, entire dose of phosphorus and half dose of potassium were applied as basal after sowing. The remaining half dose of nitrogen and potassium were applied in two equal splits at 35 and 45 DAS. The organic manure was applied to the plots as per treatment schedule and it's combined with the growth activators (eM Power) was recommended @ 12.5 kg ha^{-1}. The growth activators are applied at two equal splits on 7 and 35 DAS to the plots as per treatment schedule. The yield attributes which were observed during experiment includes cob length, number of grains per cob, cob diameter and yield. Length of five randomly selected cobs was measured from the base of the butt to last grain of the other end (apex) and the mean length per cob determined in cm. for the cob length. From the five randomly selected cobs the number of grain rows per cob were counted and mean number of rows per cob calculated and recorded as number of grain rows per cob. The diameter of cobs was measured with the help of Vernier clipper at three places, i.e., at the base, the centre and the pointed end of the cob, and the average for individual cob was worked out. Mean diameter from the five mentioned cobs was then calculated and recorded as the diameter of cob. The grain yield of each net plot was thoroughly cleaned and sun dried. The yield from each plot was recorded separately as kg plot^{-1} and then converted in kg ha^{-1}. Statistical analysis was carried out as per the procedure suggested by Panse and Sukhatme [7].

RESULTS AND DISCUSSION

All the treatments significantly influenced the crop yield components and yield of hybrid maize. Almost all yield attributing characters viz., cob length, number of grains cob^{-1}, and grain yield (Table 1) of hybrid maize were remarkably influenced by the treatments.

Cob length

The cob length of maize was significantly influenced by various the treatments. Among the treatments, maize + black gram + Vermicompost @ 5 t ha^{-1} + eM Power @ 12.5 kg ha^{-1} (T_4) recorded the highest cob length of 17.32 cm and it was on par with the treatment maize + black gram + poultry manure @ 6 t ha^{-1} + eM Power @ 12.5 kg ha^{-1} (T_5) i.e., 17.08 cm. Application of vermicompost @ 5 t ha^{-1} + eM Power @ 12.5 kg ha^{-1} (T_4) recorded higher cob length. An enhanced supply of nutrient by vermicompost and growth activators to plant from soil during growth period leads better assimilation rate and its integral part of protein, the building blocks of plant which resulted in slower leaf senescence, which may increase the photosynthesis, might be one of the reasons for increased cob length. Application of Vermicompost along with eM Power enhanced the reproductive growth of maize. So, more photo assimilates were partitioned to seed during grain filling stage which increased the number of grains cob^{-1} [8]. The least cob length of 14.87 cm was recorded in the treatment, sole maize (T_1).

Number of grains cob^{-1}

The number of grains cob^{-1} was significantly influenced by all the treatments. Maize + black gram + vermicompost @ 5 t ha^{-1} + eM Power @ 12.5 kg ha^{-1} (T_4) recorded the highest number of grains cob^{-1} of 259.47 and it was on par with the treatment maize + black gram + poultry manure @ 6 t ha^{-1} + eM Power @ 12.5 kg ha^{-1} (T_5) of 258.59. The positive and significant improvement in LAI and DMP noticed at different stages of crop growth, increased yield attributes and nutrient uptake would have resulted in enhanced cob length, number of grains cob^{-1} and thus more grain yield [9]. The treatment Sole maize (T_1) recorded the lowest number of grains cob^{-1} of 201.17.

Grain yield

The different treatments comprising of intercrops in maize at various organic manures and growth activators registered a significance influence of maize grain yield. The highest grain yield was recorded on maize + black gram + vermicompost @ 5 t ha^{-1} + eM Power @ 12.5 kg ha^{-1} (T_4) of 4751 kg ha^{-1}. However, it was on par with the treatment maize + black gram + poultry manure @ 6 t ha^{-1} + eM Power @ 12.5 kg ha^{-1} (T_5) of 4678 kg ha^{-1}. The influence of vermicompost NPK level in both of these characters mediated through increased photosynthesis efficiency and nutrient accumulation have ultimately led to production of higher biological yield under this application [10]. The lowest grain yield of 3073 kg ha^{-1} was recorded in the treatment sole maize (T_1). This might be due to lesser LAI and plant dry matter production, which decreased the yield attributes and yield of maize under this treatment [11].

Table 1 Effect of INM on yield attributes, yield and economics and maize and pulse intercropping systems

Treatments	Cobs length (cm)	No. of grains cob^{-1}	Grain yield (kg ha^{-1})	TMEY (kg ha^{-1})	B:C ratio
T_1: Sole maize	14.87	201.17	3073	3073	2.33
T_2: Sole maize + Vermicompost @ 5 t ha^{-1} + eM Power @ 12.5 kg ha^{-1}	16.01	238.04	4016	4016	2.04
T_3: Sole maize + Poultry manure @ 6 t ha^{-1} + eM Power @ 12.5 kg ha^{-1}	15.89	236.84	3990	3990	2.06
T_4: Maize + Black gram + Vermicompost @ 5 t ha^{-1} + eM Power @ 12.5 kg ha^{-1}	17.32	259.47	4751	5638	2.62
T_5: Maize + Black gram + Poultry manure @ 6 t ha^{-1} + eM Power @ 12.5 kg ha^{-1}	17.08	258.59	4678	5549	2.61
T_6: Maize + Green gram + Vermicompost @ 5 t ha^{-1} + eM Power @ 12.5 kg ha^{-1}	16.14	242.63	4092	4949	2.28
T_7: Maize + Green gram + Poultry manure @ 6 t ha^{-1} + eM Power @ 12.5 kg ha^{-1}	16.09	241.31	4068	4917	2.29
SEd	0.42	6.86	149.31	177.0	-
CD (p = 0.05)	0.91	14.89	324	384	-

Total maize equivalent yield

The treatment, maize + black gram + vermicompost @ 5 t ha^{-1} + eM Power @ 12.5kg ha^{-1} (T_4) recorded the highest total maize equivalent yield of 5638 kg ha^{-1}. It was on par with the treatment maize + black gram + poultry manure @ 6 t ha^{-1} + eM Power @ 12.5 kg ha^{-1} (T_5) of 5549 kg ha^{-1}. Thus, in respect of maize equivalent yield, maize + black gram intercropping was found better than Sole maize system. It indicated that equivalent yield was strongly influenced by the market price and yield of component crop under intercropping system. Similarly, higher maize equivalent yield produced under maize with black gram combination illustrated that intercropping was more profitable over sole cropping of maize because of superior yield attributing characters of both crops combination [12]. The lowest total maize equivalent yield of 3073 kg ha^{-1} was recorded in the treatment, sole maize (T_1).

Economics

Among the treatments, maize + black gram + vermicompost @ 5 t ha^{-1} + eM Power @ 12.5 kg ha^{-1} (T_4) recorded the highest B:C ratio of Rs. 2.62. The maize + black gram + poultry manure @ 6 t ha^{-1} + eM Power @ 12.5 kg ha^{-1} (T_5) highest B:C ratio of Rs. 2.61 treatment came next in experiments. Incorporation of vermicompost resulted in increased soil nutrient content promoted plant growth and chlorophyll, hence resulted in faster growth with enhanced yield makes higher B:C ratio [13]. The additional cost of vermicompost was compensated by the additional yield of maize and pulse. The lowest B:C ratio of Rs. 2.04 was accounted with T_2 - sole maize + vermicompost @ 5 t ha^{-1} + eM Power @ 12.5 kg ha^{-1}.

CONCLUSION

Application of vermicompost + eM Power along with recommended NPK fertilizers to maize + black gram intercropping system proved good and the best option for achieving higher yield, yield advantage and B:C ratio using optimum exploitation of natural resources and accomplish economically profitable intercropping systems.

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