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Effect of spacing, sources of nutrient and methods of zinc application on yield and yield attributes of summer greengram (*Vigna radiata* L.)

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Abstract
A field experiment was conducted during *Zaid* season of 2015-16 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Allahabad. The experiment consisted of two different spacings (30 cm × 10 cm and 45cm × 6.7 cm), three sources of nutrient (100% Organic, 50% Organic + 50% Inorganic and 100% Inorganic on the basis of N & K) and three methods of Zn application (No application, Soil application at 12.5 kg $ZnSO_4$ ha^{-1} and foliar spray at 0.5% $ZnSO_4$) which was laid out in Factorial Randomised Block Design (FRBD) with three replications. Thus, there were in all 18 treatment combinations. From the present investigation it can be concluded that for obtaining higher yield greengram is to be grown during *zaid* season with the spacing of 30 cm × 10 cm along with nutrient sources 50% Organic (1.50 tonne Farm yard manure ha^{-1} + 83.35 kg Bone meal ha^{-1}) + 50% Inorganic (55.56 kg Diammonium phosphate ha^{-1} +12.50 kg Muriate of potash ha^{-1}) and Soil application of Zn at 12.5 kg $ZnSO_4$ ha^{-1}.

Keywords: Summer greengram, Spacing, Nutrient sources, Zinc, Integrated nutrient management

Introduction

Pulses are commonly known as food legumes which are secondary to cereals in production and consumption in India. The United Nations, declared 2016 as "International Year of Pulses" (IYP) to heighten public awareness of the nutritional benefits of pulses as part of sustainable food production aimed at food security and nutrition. Green gram [*Vigna radiata* (L.) Wilczek] also known as Mungbean is a self pollinated leguminous crop which is grown during *Kharif* (July- October) as well as summer (March- June) seasons in arid and semi arid regions of India. It is a short duration crop, fits well in various multiple and intercropping systems. The farmers usually grow Mungbean without maintaining proper planting density. They hesitate to grow Mungbean in rows, although row planting facilitates easy intercultural operations resulting in higher yield. Improper spacing reduced the yield of Mungbean up to 20 to 40% due to competition for light, space, water and nutrition. Optimum spacing favours the plants to grow in their both aerial and underground parts through efficient utilization of solar radiation and nutrients (Miah *et al*. 1990) [10]. Among many other crop production constraints, appropriate varieties and inter-row spacing are the most important, which contribute substantially to the seed yield of mungbean (Ismail and Hall 2002) [2].

The most limiting factor that has affected the production of crops and productivity of Indo Gangetic plain is fertilizer: through imbalanced and indiscriminate use on one hand and withdrawal of organic matter from the schedule of inputs on the other (Kumar *et al.*, 2008) [7]. Therefore integrated nutrient management (INM) has been an increasing necessity especially for the sub-tropical Indian soils. INM intended for four major goals to be achieved. These are to maintain soil productivity, to ensure sustainable productivity, to prevent degradation of the environment and to reduce expenditure on the cost of chemical fertilizers. An application of organic manure along with fertilizer not only increases the efficiency of the latter, but also has beneficial effects on the succeeding crop and soil. Despite several hurdles, for overall interest of sustaining soil productivity, the use of organic manure has to be encouraged.

Intensive agriculture coupled with continuous use of NPK fertilizers has remarkably increased production but simultaneously brought about problems related to micronutrient deficiencies, particularly that of Zn in soil. Zinc is one of the essential plant micronutrients and its importance for crop productivity is similar to that of major nutrients.

Lack of zinc causes deficiency in formation of RNA and protein. Therefore, the plant with lack of zinc is poor in amount of protein.Crops require only small amount of Zn for their normal growth but its application rate is high due to very low fertilizer-use efficiency. Zn has its role in various enzymic reactions, growth processes, hormone production and protein synthesis and also the translocation of photosynthates to reproductive parts thereby leading to higher yield of the crop. The balanced supply of nutrients could have induced more flower and fruiting bodies production and moreover, reduction in flower shedding due to foliar spray (Keerthi *et al*., 2015) [5].

Therefore, keeping the above facts in view, the present investigation was undertaken to examine the impact of spacing, sources of nutrient and method of zinc application on yield attributes and productivity of greengram.

Materials and methods

The experiment was carried out during *Zaid* season of 2015-16 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Allahabad, which is located at 25^0 24' 42" N latitude, 81^0 50' 56" E longitude and 98 m altitude above the mean sea level. This area is situated on the right side of the river Yamuna by the side of Allahabad Rewa Road about 5 km away from Allahabad city.

The soil was sandy loam with pH 7.4, organic carbon 0.43%, available nitrogen 235.25 kg/ha, phosphorus 15.60 kg/ha, potassium 345.22 kg/ha and Zn status of 0.84 ppm. The treatments comprised of two different spacings (30 cm × 10 cm and 45cm × 6.7 cm), three sources of nutrient (100% Organic, 50% Organic + 50% Inorganic and 100% Inorganic on the basis of N & K) and three methods of Zn application (No application, Soil application at 12.5 kg $ZnSO_4$ ha^{-1} and foliar spray at 0.5% $ZnSO_4$) which was laid out in Factorial Randomised Block Design (FRBD) consisting of eighteen treatment combinations with three replications; plot size was 2.5 x 2.7 m for crop seed rate is 25 kg ha^{-1} (*Vigna radiata* L.) Cv. Samrat PDM-139. Greengram was sown on 12th April 2016 and the recommended dose was 20 kg N + 50 kg P_2O_5 + 15 kg K_2O/ha. Full dose of Nitrogen, phosphorus and potassium applied as Di-ammonium phosphate and Muriate of potash for inorganic sources of nutrient and Farm yard manure + Bone meal for organic sources of nutrient on the basis of N & K was applied at the time of sowing of greengram. Zn is applied in the form of $ZnSO_4$ as basal at the time of sowing and as foliar spray at 25 and 45 DAS in defined plots according to treatment combinations. The rainfall during the crop season was 9.4 mm in 5 rainy days occurred from sowing to harvesting during 2016.The other usual common packages of practices were followed time to time and periodical growth observations were recorded at an interval of 15 days. The crop was harvested on 9th June. At harvest, grain and straw yield of crop were recorded. Nitrogen content in grain was determined by modified Kjeldahl's method (Jackson, 1973) [3]. Economics and system productivity were calculated the basis of prevailing market prices.

Results and discussion

Spacing effect: The data revealed that greengram grown during *zaid* season with the spacing of 30cm × 10cm was found superior over Spacing 45cm x 6.7cm as it recorded significantly higher value of test weight. However, the spacing had no significant influence on grain yield, stover yield and harvest index. Spacing 30cm x 10cm increased grain yield (791.77 kg ha^{-1}) and stover yield (2561.59 kg ha^{-1}) by 4.76 % and 1.75 % over spacing 45cm x 6.7cm respectively. The favorable effect of spacing 30cm × 10cm might be due to under 45cm x 6.7cm, the less intra row spacing increases competition for solar radiation that ultimately stunt growth of some intra row plants in vegetative phase and they were unable to reach reproductive phase, even though the yield contributing variables were high when compared to the recommended spacing, the total grain yield was low due to lesser plant population achieved pod forming stage at the time of harvesting. Sathyamoorthi *et al*. (2008) [12] and Sekhon *et al*. (2002) [13] had also reported the similar results in greengram, which support the results of present investigation.

Response to nutrient sources: Data presented in (Table - 1) indicated that among the sources of nutrient (50% Organic + 50% Inorganic) was found superior over 100% Inorganic and 100% organic sources of nutrient as it recorded significantly higher number of seeds pod^{-1}, grain yield, stover yield and, test weight. Nutrient source 50% Organic + 50% Inorganic increased grain yield (812.35 kg ha^{-1}) and stover yield (2585.19 kg ha^{-1}) by 11.23 % over 100% organic and 5% over 100% Inorganic sources of nutrient respectively. The improvement in yield and yield attributes might be due to control release of nutrients in the soil through mineralization of organic manure which might have facilitated better crop yield. These results are line with those reported by Afzal and Bano (2008) [1] in wheat and Katkar *et al*. (2011) [4] in sorghum-wheat system. According to Mandal and Pramanick (2014) [9] integration of inorganic fertilizers and organic manures resulted in better yield may be due to organic manures provide a good substrate for the growth of micro-organisms and maintain a favourable nutrient supply environment and improve soil physical properties in greengram. Also the findings of Kumpawat (2010) [8] in blackgram, Nayek *et al*. (2014) [9] in sesame and kumar *et al*. (2014) [6] in rice an accordance with the same.

Effect of Methods of zinc application: Soil application (basal) of $ZnSO_4$ at 12.5 kg ha^{-1} significantly recorded maximum number of pods $plant^{-1}$, seeds pod^{-1}, grain yield, harvest index and test weight over $ZnSO_4$ at 0.5% as Foliar Spray and Fertilized Control (No application). Soil application of Zn increased grain yield (812.35 kg ha^{-1}) by 11.54% over No application of Zn. The significant increase in yield and yield attributes might be due to addition of $ZnSO_4$ could have increased the availability of micronutrients in soil as well as increased the rate of photosynthesis, also observed that application of $ZnSO_4$ could have enhanced the plant nutrition increases the assimilate production and photosynthesis efficiency at seed filling stage. Similar findings was reported by Keerthi *et al*. (2015) [5].

It is concluded that for obtaining higher yield greengram is to be grown during *zaid* season with the spacing of 30 cm × 10 cm along with nutrient sources 50% Organic (1.50 tonne Farm yard manure ha^{-1} + 83.35 kg Bone meal ha^{-1}) + 50% Inorganic (55.56 kg Diammonium phosphate ha^{-1} + 12.50 kg Muriate of potash ha^{-1}) and Soil application of Zn at 12.5 kg $ZnSO_4$ ha^{-1}.

Table 1: Effect of spacing, sources of nutrient and methods of zinc application on yield and yield attributes of summer greengram at harvest stage.

Treatments	Number of pods plant^{-1}	Number of seeds pod^{-1}	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Test weight (g)	Harvest index (%)
Plant Spacing						
S_1: 30cm x 10cm	12.20	9.21	791.77	2561.59	38.64	23.60
S_2: 45cm x 6.7cm	14.72	9.42	755.56	2517.70	38.01	23.04
F test	S	NS	NS	NS	S	NS
SEm (±)	0.26	0.10	18.16	20.56	0.15	0.42
CD (P = 0.05)	0.74	-	-	-	0.43	-
Sources of Nutrient						
N_1: 100% Organic (FYM @3t ha^{-1} + BM @166.7kg ha^{-1})	12.48	9.07	730.04	2571.60	37.50	22.11
N_2: 50% Organic + 50% Inorganic (FYM @1.50 t ha^{-1} + BM @83.35 kg ha^{-1}+ DAP @55.56 kg ha^{-1}+ MOP @12.50 kg ha^{-1})	13.85	9.57	812.35	2585.19	39.20	23.88
N_3: 100% Inorganic (DAP @111.12 kg ha^{-1}+ MOP @25 kg ha^{-1})	14.04	9.31	778.60	2462.14	38.28	23.97
F test	S	S	S	S	S	S
SEm (±)	0.31	0.12	22.24	25.18	0.18	0.51
CD (P = 0.05)	0.91	0.34	63.92	72.36	0.52	1.46
Methods of Zinc application						
Z_0: Fertilized Control (No application)	12.35	9.06	727.57	2539.09	37.08	22.31
Z_1: $ZnSO_4$ @12.5 kg ha^{-1} (Soil application)	14.85	9.58	812.35	2537.86	39.77	24.19
Z_2: $ZnSO_4$ @0.5% (Foliar spray)	13.17	9.31	781.07	2541.98	38.13	23.46
F test	S	S	S	NS	S	S
SEm (±)	0.31	0.12	22.24	25.18	0.18	0.51
CD (P = 0.05)	0.91	0.34	63.92	-	0.52	1.46

FYM- Farm yard manure; BM- Bone meal; DAP- Di-ammonium phosphate; MOP- Muriate of potash; NS- Non Significant at $P > 0.05$

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