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Productivity and Quality of Maize (*Zea mays* L.) as influenced by Phospho Enriched Compost and Fertility Levels in Southern Plains of Rajasthan

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Abstract: The investigation was carried out to study the effect of phospho enriched compost and fertility levels on productivity and quality of maize (*Zea mays* L.) in Typic Haplustepts soil of Sub-Humid Southern Hills and Aravalli Region of Rajasthan. The experiment was undertaken during kharif 2018 and 2019 at Instructional Farm (Agronomy), Rajasthan College of Agriculture, Udaipur (Rajasthan). The author evaluated four levels of phospho enriched compost (PEC) i.e. control, PEC @ 2.0, 4.0 and 6.0 t ha^{-1} and four levels of fertility i.e. control, 50% RDF + foliar spray of Zn @ 0.5%, 75% RDF + foliar spray of Zn @ 0.5% and 100% RDF + foliar spray of Zn @ 0.5%. The increasing levels of phospho enriched compost and fertility up to 6 t ha^{-1} and 100% RDF + foliar spray of Zn @ 0.5%, respectively increased significantly the seed yield, stover yield and protein content in seeds of maize. However, the combined application of phospho enriched compost @ 6 t ha^{-1} and 100% RDF + foliar spray of Zn @ 0.5% was found to record significantly higher seed and stover yield.

Key words: Productivity, quality, P enriched compost, fertility, maize

Maize (*Zea mays* L.) is one of the most important cereal crops of the world and finds a place in the human food, animal food, fodder and industrial raw material. Maize belongs to family gramineae and popularly known as corn, ranking third among the food crops, next to rice and wheat in the world and ranking fourth after rice, wheat and sorghum in India. The productivity of maize is very high because of its C_4 nature of plants and it is very efficient in converting solar energy into production of dry matter. The crop has high genetic yield potential and hence, it is called as Miracle crop and as the "Queen of cereals". In India occupying 8.87 m ha area with production of 22.63 million tones and productivity status of 2567 kg ha^{-1}, respectively (Anonymous, 2019). In the state of Rajasthan, it covers an area of 0.87 m ha with production and productivity of 1.16 million tones and 1335 kg ha^{-1}, respectively (Anonymous, 2019). The sub-optimal nutrition status and low fertility soils are among the many reasons for low productivity of this crop.

Addition of organic matter into the soil in the form of compost is a feasible strategy to enhance the soil fertility (Zayed and Abdel, 2005). Hence, conversion of agricultural residues into enriched compost by value-addition through cheap minerals like rock phosphate can improves the soil fertility as well as crop productivity (Gaind *et al*., 2006). Phospho enriched compost (PEC) is considered a valuable organic fertilizer as it supplies nutrients for the crop which results in saving cost of chemical fertilizers (Erhart *et al*., 2005). Besides, it provides all the essential nutrients in readily available forms, enhances uptake of these nutrients by the plants and play a major role in improving growth and yield of crops (Sreenivas *et al*., 2000). PEC also acts as a niche for microbes and enriches the soil with a variety of the indigenous micro-flora and fauna (Paul, 2007).

Nitrogen is known to be an essential plant nutrient for growth and development. It is the first limiting plant nutrient, has a great influence on crop growth, yield and its quality. Nitrogen is a vital plant nutrient and a major determining factor required for maize production (Shanti *et al*., 1997). Its availability in sufficient quantity throughout the growing season is essential for optimum maize growth (Haque *et al*., 2001). Phosphorus is a limiting nutrient for terrestrial biological productivity. The availability of "new" P in ecosystems is restricted by the rate of release of this element during soil weathering. Soil P exists

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in inorganic and organic forms. The intergrades and dynamic transformations between the forms occur continuously to maintain the equilibrium conditions (Hedley *et al.*, 1982). Its low concentration and solubility (<0.01 mg P kg^{-1}) in soils, however, make it a critical nutrient limiting plant growth. Phosphorus is the second essential nutrient required to higher yield of maize. Consequently, lack of phosphorus is as important as the lack of nitrogen limiting maize performance (Gul *et al.*, 2015). It is important for seed and fruit formation and crop maturation. Likewise, potassium is an essential nutrient and is also the most abundant cation in plants. It plays essential roles in enzyme activation, protein synthesis, photosynthesis, osmoregulation, stomatal movement, energy transfer, phloem transport, cation-anion balance and stress resistance (Gul *et al.*, 2015). Majority of the soils of the state are deficient in zinc (Singh and Singh, 1981), it is necessary to include Zn in fertilization strategy. Application of zinc either through soil or through foliar spray or both are recommended for improving the grain zinc content (Cakmak and Kutman, 2018). Crop plants have the capability to absorb zinc through leaf surface; hence, foliar spray of zinc is the best way for enhancing its utilization in the growing tissues (Khoshgoftarmanesh *et al.*, 2010). Hence, looking to the above facts the present investigation was carried out to study the effect of the phospho enriched compost and fertility on yield and quality of maize.

Materials and Methods

Experimental site and soil

The experiment was conducted during kharif 2018 and 2019 at the Instructional Farm (Agronomy), Rajasthan College of Agriculture, Udaipur situated at an altitude of 579.5 metres above mean sea level and at 24°34′ latitude and 73°42′ longitude. The region falls under agro-climatic zone-IVa (Sub- humid Southern Plain and Aravalli Hills) of Rajasthan. The climate of the study area is sub-humid with an average maximum and minimum temperatures ranged between 27.9 to 34.4°C & 17.2 to 24.0°C and 28.7 to 33.6°C & 18.6 to 24.1°C, respectively during *kharif* season July, 2018 to October, 2018 and July, 2019 to October, 2019. Soil of the experiment was clay loam in texture, saline in reaction, medium in organic matter; low in available N, P, high in available K and low in available zinc

Raw material for phospho enriched compost (PEC)

For the preparation of PEC, four mineral and organic sources viz., rock phosphate, mica, maize stover and FYM were used. Rock phosphate and mica were collected from mining sites in Udaipur district of Rajasthan, whereas maize stover and FYM were obtained from the Farm section of Rajasthan College of Agriculture, Udaipur.

Preparation of PEC: For the preparation of PEC, 15 kg air dried maize stover chopped in to 5-6 cm size was soaked in water for 24 hours. After soaking, it was mixed thoroughly with 10% of rock phosphate (RP) and 5% waste mica. To reduce the C:N ratio of maize stover, urea solution @ 0.25 kg N per 100 kg of maize stover and fresh cow dung @ 10 kg per 100 kg of maize stover was added as natural inoculants. Phosphate solubilizing microorganism @ 50 g per 100 kg was also added to maize stover. After that the whole composting mass was mixed thoroughly and put in the cemented pits and covered with jute beg sheets for maintaining moisture. To provide adequate aeration turning was performed after 15, 30 and 60 days of composting and throughout the experiment moisture was maintained to 60% of water holding capacity. The composting was continued for 120 days. Fully matured PEC used in the experiments had the 0.845+0.017% N, 1.218+0.024% P, 1.159+0.023% K and 35.2+0.7 ppm Zn content.

Experimental design and treatments:

The experiment was laid out in factorial randomized block and replicated thrice in the plot size of 4.0 m x 3.0 m (12 m^2). The treatments comprised of four levels of PEC viz., control, 2.0, 4.0 and 6.0 t ha^{-1} PEC and four levels of fertility viz., control, 50% RDF + foliar spray of Zn 0.5%, 75% RDF + foliar spray of Zn 0.5% and 100% RDF + foliar spray of Zn 0.5%. The maize var. PEHM-2 was sown in lines 60 cm apart. As per the treatments, whole quantity of PEC was broadcasted and incorporated in to the soil before 15 days of sowing. The recommended dose of nitrogen (120 kg ha^{-1}) was applied in two equal splits, the half as basal and the remaining half was top

Table 1. Effect of phospho-enriched compost and fertility levels on seed yield of maize during both years

Treatments	2018					2019				
	PEC_0	PEC_1	PEC_2	PEC_3	Mean	PEC_0	PEC_1	PEC_2	PEC_3	Mean
F_0	2228.42	3013.02	3609.22	3958.74	3202.35	2246.12	3043.97	3669.66	4037.04	3249.20
F_1	3122.18	3579.06	3701.81	4052.69	3613.94	3173.76	3637.33	3780.10	4140.02	3682.80
F_2	3638.02	3757.65	4253.55	4553.95	4050.80	3699.91	3819.50	4342.88	4647.26	4127.39
F_3	3816.78	4147.50	4661.96	4939.43	4391.42	3882.25	4217.14	4759.45	5037.76	4474.15
Mean	3201.35	3624.31	4056.64	4376.20		3250.51	3679.49	4138.02	4465.52	
C.D. at 0.05	PEC				185.01	PEC				179.65
	Fertility				185.01	Fertility				179.65
	PEC X Fertility				370.01	PEC X Fertility				359.30

dressed at the time of first irrigation. The basal dose was applied through urea after adjusting the quantity supplied through diammonium phosphate. The whole quantity of phosphorus (60 kg ha^{-1}) through diammonium phosphate and potassium (30 kg ha^{-1}) through muriate of potash and foliar spray of zinc (@ 0.5%) through $ZnSO_4.7H_2O$ at 35 days after sowing with the help of 'Knapsack Sprayer'. The test crop was sown on July 7, 2018 (I^{st} crop), July 6, 2019 (II^{nd} crop) and harvested on October 24, 2018 (I^{st} crop) and October 26, 2019 (II^{nd} crop), respectively. The seeds obtained from the produce of individual plot were recorded as seed yield kg $plot^{-1}$ and later it was converted into kg ha^{-1}. The seed and stover yield were recorded from net plot area of each treatment. Seed samples collected at harvest for all the treatments was analyzed for N content following standard methods (Jackson, 1973). Protein content in seed (%) was obtained by multiplying the per cent N content by 6.25 (AOAC, 1960).

Statistical analysis: The data recorded for different parameters were analyzed with the help of analysis of variance (ANOVA) technique for a factorial randomized block design as described by (Panse and Sukhatme, 1985). The results are presented at 5% level of significance (P=0.05).

Results and Discussion

Yield

The application of PEC and fertility levels enhanced the seed, stover and biological yield of maize significantly during both the years. The significantly maximum seed yield (4420.86 kg ha^{-1}) and stover yield (7106.42 kg ha^{-1}) were observed under the treatment PEC @ 6 t ha^{-1} during pooled analysis (Table 1 and 2). The increase in seed and stover yield was the extent of 13.20 and 27.01%, 12.32 and 26.99% with the application of PEC @ 2, 4 and 6 t ha^{-1}, respectively as compared to control. The significant increase in seed and stover yield under the influence of PEC was largely a function of improved growth and yield attributes which eventually contributed in increased seed and stover yield. The increase in yield due to addition of PEC might be the result of overall improvement in soil physico-chemical properties of soil due to decrease in bulk density, pH, electrical conductivity and increase in particle density, porosity, water holding capacity and cation exchange capacity (Devi *et al*., 2018; Patil *et al*., 2018). These beneficial effects favored greater availability

Table 2. Effect of phospho-enriched compost and fertility levels on stover yield of maize during both years

Treatments	2018					2019				
	PEC_0	PEC_1	PEC_2	PEC_3	Mean	PEC_0	PEC_1	PEC_2	PEC_3	Mean
F_0	3577.78	4790.68	5807.44	6372.48	5137.10	3661.58	4898.75	5935.84	6512.18	5252.09
F_1	5001.23	5689.64	5948.60	6501.98	5785.36	5113.51	5815.68	6079.82	6644.27	5913.32
F_2	5852.83	6001.48	6857.65	7323.90	6508.96	5982.14	6133.76	7007.05	7482.62	6651.39
F_3	6123.94	6610.43	7496.32	7921.63	7038.08	6258.67	6754.89	7658.49	8092.31	7191.09
Mean	5138.95	5773.06	6527.50	7030.00		5253.97	5900.77	6670.30	7182.85	
CD (P=0.05)	PEC				295.02	PEC				300.92
	Fertility				295.02	Fertility				300.92
	PEC X Fertility				590.05	PEC X Fertility				601.85

of plant nutrients and their steady supply throughout growth for optimum development. The maximum nutrient availability and congenial environment for their uptake, synthesis of carbohydrate and their efficient portioning into different sinks including reproductive structures which ultimately brought about significant improvement in crop yields (Biswas, 2011; Meena, 2017). The beneficial response of PEC to yield attributes and yield might also be attributed to the availability of sufficient amounts of plant nutrients throughout the growth period and especially at critical growth periods of crops resulting in better uptake (Doodhawal *et al*. 2021a), plant vigour and superior yield attributes (Abrol *et al*., 2007). The incorporation of PEC in the soil ensures successive and almost continuous supply of macro and micro nutrients to the maize over the entire crop growth period (Biswas, 2011). This improvement suggested that during growth and development of reproductive structure greater availability of metabolites and nutrient due to PEC application synchronized with the demand. The higher availability of nutrients in soil due to PEC application during seed development might have retarded senescence and resulted in large filling period for greater seed and stover yield of maize (Biswas and Narayansamy, 2006). The results corroborate the findings of Meena (2017), attributing the effect of PEC to the release of P from rock phosphate (RP) during decomposition and partially the additive effect of organics. The organics enriched with inorganic P, when added to soil are subjected to biological mineralization and there is a production of organic-P fractions as phospho-humus complexes which easily supply nutrients to plants. The possible reason could be ascribed to the favorable effect on soil properties due to formation of more humus colloidal complex coupled with higher nutrient content of PEC and it contributes directly to the nutrients pool of the soil (Manna *et al*., 2001; Biswas, 2011). The gradual release and steady supply of nutrients from PEC throughout the growth and development of plants maintained the photosynthetic efficiency and production of metabolites at higher level and later on the translocation of photosynthates to various sinks resulting into higher seed and stover yield of maize. Similar findings were also reported by Akande *et al*., 2008; Patil *et al*., 2011. The interrelationship between various yields attributes of the crop and its seed and stover yield had also been observed by Biswas (2011); Mali *et al.* (2017); Meena (2017); Meena (2019); Kharche *et al*. (2020).

The significantly maximum seed yield (4432.79 kg ha^{-1}) and stover yield (7114.58 kg ha^{-1}) was recorded under F_3 (100% RDF + foliar spray of Zn 0.5%) followed by F_2 (75% RDF + foliar spray of Zn 0.5%) and F_1 (50% RDF + foliar spray of Zn 0.5%) treatments as compared to control (F_0) in pooled basis, respectively. The per cent increase in seed and stover yield of maize were in order of 37.42 and 36.96 in pooled basis due to application of 100% RDF + foliar spray of Zn 0.5% (F_3), 75% RDF + foliar spray of Zn 0.5% (F_2) and 50% RDF + foliar spray of Zn 0.5% (F_1) as compared to control (F_0), respectively (Table 1 and 2). Increase in seed and stover yield might be due to better nutritional status of the crop in the soil as evidenced by their uptake in the plant. The increased supply of nitrogen, phosphorus and potassium their higher uptake by plants might have stimulated the rate of various physiological processes in plant and led to increased growth and yield parameters and resulted in increased yields (Harender *et al*., 2018; Reddy *et al*., 2018). The significant improvement in seed and stover yield under the influence of application of fertilizer with foliar spray of zinc @ 0.5% was largely a function of improved growth and the consequent increase in different yield and yield attributes (Abrol *et al*., 2007). Similar results were also reported by Jha *et al*. (2015) and Belay and Adare (2020). The significant increase in straw yield due to application of 100% RDF + foliar spray of zinc @ 0.5% could be ascribed to their direct influence on stover production by virtue of increased photosynthetic efficiency (Kumar *et al.,* 2015). The profound influence of nutrient application on biological yield seems to be on account of its influence on vegetative (stover) and reproductive growth (seed) (Kumar *et al.,* 2017). Similar results were also reported by Vimalan *et al.* (2019) and Belay and Adare (2020).

The combined effect of PEC and fertility levels with foliar spray of zinc showed positive interaction on seed yield of maize in both the years and in pooled analysis (Table 1 and 2). Application of each PEC treatment irrespective of fertility levels with foliar spray of zinc and application of fertility with foliar spray of zinc on each levels of PEC resulted in significant increase in seed yield (4988.59 kg ha^{-1}) and stover yield (8006.97 kg ha^{-1}) of maize with maximum was found under 6 t PEC ha^{-1} + 100% RDF + foliar spray of Zn 0.5% (PEC_3F_3) while the minimum under control (PEC_0F_0) on pooled basis, respectively. The increase in yield is associated with the release of macro- and micro-nutrients during the course of microbial decomposition through improvement in soil enzymatic activities (Doodhawal *et al*., 2021b). The PEC also act as source of energy for soil micro flora, which bring about transformation of inorganic nutrients held in the form of fertilizers in a form that is readily utilized by growing plants. The beneficial effect of PEC addition is also related to improvement in soil physical properties (Devi *et al*., 2018; Patil *et al*., 2018). The beneficial response of PEC to yield might also be attributed to the better availability of plant nutrients in sufficient amounts throughout the growth period and especially at critical crop growth stage, which resulted in better plant vigor and superior yield attributes. Combined use of phospho enriched compost and fertilizer has been found to be promising not only in maintaining higher productivity but also in stable crop yields (Verma *et al*., 2018; Pandiyana *et al*., 2020).

Table 3. Effect of phospho-enriched compost and fertility levels on protein content in seeds of maize during both years

Treatment	Protein content (%)	
	2018	2019
Phospho-enriched compost (t ha^{-1})		
Control (PEC0)	8.76	8.94
2 (PEC1)	9.43	9.61
4 (PEC2)	9.78	9.96
6 (PEC3)	9.96	10.14
SEm+	0.039	0.043
CD (P=0.05)	0.112	0.124
Fertility levels ((kg ha^{-1})		
Control (F0)	8.79	8.97
50% RDF+foliar spray of Zn 0.5% (F1)	9.45	9.63
75% RDF+foliar spray of Zn 0.5% (F2)	9.70	9.88
100% RDF+foliar spray of Zn 0.5% (F3)	9.99	10.18
SEm+	0.039	0.043
CD (P=0.05)	0.112	0.124

Protein content

The application of increasing levels of PEC and fertility significantly increased the protein content in seed of maize during both the years (**Table 3**). The highest protein content of maize seed (10.05%) was obtained under PEC_3 (6 t ha^{-1}) which was significantly superior over the PEC_2 (4 t ha^{-1}) and PEC_1 (2 t ha^{-1}) treatments as well as control (PEC_0). The per cent increase in protein content of maize seed were in order of 13.53, 11.48 and 7.59% on pooled basis due to application of 6, 4 and 2 t PEC ha^{-1} as compared to control (PEC_0), respectively. The increase in protein content under PEC application can be assigned to the availability of all the essential nutrients which are present in organic matter and their continuous mineralization (Survase *et al*., 1986). Nitrogen is an essential constituent of protein, increase in N content led to higher protein content in seed. The significant increase in protein content in seed with an application of PEC seems to be due to increased availability of most of the nutrients to the plant along with nitrogen. Thus, increased nitrogen was ultimately utilized by the plant for synthesis of protein and its translocation in seed. These results are in agreement with those of Mali *et al*. (2017) and Meena (2019).

The protein content of maize seed was significantly affected by fertility levels with foliar spray of zinc during both the years. The highest protein content of maize seed (10.08%) was recorded under F_3 (100% RDF + foliar spray of Zn 0.5%) which was significantly superior over the F_2 (75% RDF + foliar spray of Zn 0.5%) and F_1 (50% RDF + foliar spray of Zn 0.5%) treatments as well as control (F_0) on pooled basis. The per cent increase in protein content of maize seed were in order of 13.57, 10.24 and 7.42% in combined year basis due to application of 100% RDF + foliar spray of Zn 0.5% (F_3), 75% RDF + foliar spray of Zn 0.5% (F_2) and 50% RDF + foliar spray of Zn 0.5% (F_1) as compared to control (F_0), respectively. The protein content of seeds is related to its nitrogen content, when chemical fertilizer was used, the nitrogen consumption of plant increases and it improves quality of maize due to increase in protein content of seed. Several workers reported that in maize, protein content were probably genetically-controlled characters

(Wafaa, *et al.*, 2002). Similar results were also reported by Ashoka *et al.* (2009).

Conclusion

On the basis of experimental finding, it can be concluded that the application of PEC @ 6 t ha^{-1} and 100% RDF + foliar spray of zinc @ 0.5% along with the recommended dose of fertilizer results in significantly higher yield and protein content of maize under Typic Haplustepts soil of Sub-Humid Southern Hills and Aravalli Region of Rajasthan.

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References

AOAC 1960. Association of official agricultural chemists. Official Methods of Analysis. 8th Education Association Official Agricultural Chemists. Washington, DC.

Abrol, V., Sankar, G.R.M., Singh, M. and Jaiswal, J.S. 2007. Optimization of fertilizer requirement of maize based on yield and rainfall variation from permanent manurial trials under dry-sub humid Inceptisol. *Indian Journal of Dryland Agriculture Research and Development* 22:15-21.

Akande, M.O., Oluwatoyinbo, F.I., Kayode, C.O. and Olowokere, F.R. 2008. Response of maize and okra intercrop relayed with cowpea to different levels of cow dung amended phosphate rock. *African Journal of Biotechnology* 7(17): 3039-3043.

Anonymous 2019. *Fertiliser Statistics 2018-19*. The Fertiliser Association of India, New Delhi.

Ashoka, P., Anand, S.R., Mudalagiriyappa and Smitha, R. 2009. Effect of macro and micronutrients with organics on growth, quality, yield and economics of baby corn (*Zea mays* L.) in Tungabhadra Command area. *Crop Research* 37: 15-18.

Belay, M. and Adare, K. 2020. Response of growth, yield components, and yield of hybrid maize (*Zea mays* L.) varieties to newly introduced blended NPS and N fertilizer rates at Haramaya, Eastern Ethiopia. *Cogent Food & Agriculture* 6 (1): **1771115**.

Biswas, D.R. 2011. Nutrient recycling potential of rock phosphate and waste mica enriched compost on crop productivity and changes in soil fertility under potato-soybean cropping sequence in an Inceptisol of Indo-Gangetic Plains of India. *Nutrient Cycling in Agroecosystems* 89*:* 15-30.

Biswas, D.R. and Narayanasamy, G. 2006. Rock phosphate enriched compost: an approach to improve low grade Indian rock phosphate. *Bioresource Technology* 97: 2243-2254.

Cakmak, I. and Kutman, U.B. 2018. Agronomic biofortification of cereals with zinc: A review. *European Journal of Soil Science* 69: 172-180.

Devi, Y.S., Luikham, E., Singh, M.S., Lhungdim, J. and Chanu, Y.B. 2018. Influence of integrated nitrogen management practices on yield attributes, yield, nutrient uptake and economics of hybrid maize (*Zea mays* L.). *International Journal of Current Microbiology and Applied Sciences* 7(10): 2469-2476.

Doodhawal, K., Meena, R.H., Jat, G., Jain, D., Sekahawat, A.S., Aechra, S. and Bamboriya, J.S. 2021a. Productivity and nutrient uptake of maize as influenced by phospho-enriched compost and fertility levels in a typic haplustept soil. *Indian Journal of Fertilisers* 17(10): 1030-1036.

Doodhawal, K., Meena, R.H., Jat, G., Jain, D., Choudhary, R.S., Choudhary, R., Sharma, J.K., Meena, M. and Yadav, S.K. 2021b. Soil biological properties as influenced by phospho-enriched compost and fertility levels in maize (*Zea mays*). *Indian Journal of Agricultural Sciences* 91(10): 1537-1541.

Erhart, E., Hartl, W. and Putz, B. 2005. Biowaste compost affects yield, nitrogen supply during the vegetation period and crop quality of agricultural crops *European Journal of Agronomy* 23 (3): 305-314.

Gaind, S., Pandey, A. K. and Lata, N. 2006. Microbial biomass, P nutrition and enzyme activities of wheat soil in response to P enriched organic and inorganic manures. *Journal of Environment Science and Health,* 41(2): 177-187.

Gul, S., Khan, M.H., Khanday, B. A and Nabi, S. 2015. Effect of sowing methods and NPK levels on growth and yield of rainfed maize (*Zea mays* L.) Hindawi Publishing Corporation, *Scientifica* 1-6**. ????**

Haque, M.M., Hamid, A. and Bhuiyan, N.I. 2001. Nutrient uptake and productivity as affected by nitrogen and potassium application levels N maize/sweet potato intercropping system. *Korean Journal* of *Crop Science* 46: 1-5.

Harender, H. S., Singh, N., Rathi, N., Malik, K. and Kavinder. 2018. Influence of different dose of plant nutrient on growth rate, nutrient uptake and yield of maize (*Zea mays* L.). *International Journal of Pure and Applied Bioscience* 6(1): 795-801.

Hedley, M.J., Stewart, J.W.B. and Chauhan, B.S. 1982. Changes in inorganic and organic soil phosphorus fractions induced by cultivation and by laboratory incubations. *Soil Science of American Journal* 46: 970-976.

Jackson, M.L. 1973. *Soil Chemical Analysis*. Prentice Hall of India Pvt. Ltd., New Delhi, 498 p.

Jha, D.P., Sharma, S.K. and Amarawat, T. 2015. Effect of organic and inorganic sources of nutrients on yield and economics of blackgram (*Vigna mungo* L.) grown during kharif. *Agricultural Science Digest* 35(3): 224-228.

Kharche, P.P., Bhondave, T.S. and Sawant, A.C. 2020. Effect of organic source of nitrogen on growth, yield and economics of baby corn. *Current Journal of Applied Science and Technology* 39(16): 66-75.

Khoshgoftarmanesh, A.H., Schulin, R., Chaney, R.L., Daneshbakhsh, B. and Afyuni, M. 2010. Micronutrient efficient genotypes for crop yield and nutritional quality in sustainable agriculture: A review. *Agronomy of Sustainable Development* 30: 83-107.

Kumar, D., Arvadiya, L.K., Desai, K.L., Usadadiya, V.P. and Patel, A.M. 2015. Growth and yield of chickpea (*Cicer arietinum* L.) as influenced by graded levels of fertilizers and bio-fertilizers. *The Bioscan* 10 (1): 335-338.

Kumar, Rakesh, Kumawat, N., Kumar, S., Singh, A.K. and Bohra, J.S. 2017. Effect of NPKS and Zn fertilization on growth, yield and quality of baby corn. *International Journal of Current Microbiology and Applied Science* 6(3): 1392-1428.

Mali, M. K., Meena, R.H. and Jat, G. 2017. Effect of composted rock phosphate with organic materials on yield nutrient uptake and soil fertility after harvest of Maize (*Zea mays* L.). *International Journal of Current Microbiology and Applied Science* 6(6): 901-909.

Manna, M.C., Ghosh, P.K., Ghosh. B.N. and Singh, K.N. 2001. Comparative effectiveness of phosphate enriched compost and single superphosphate on yield, uptake of nutrients and soil quality under soybean-wheat rotation. *Journal of Agricultural Sciences* 137: 45-54.

Meena, M. 2019. Effect of enriched compost and zinc on soil fertility and productivity of blackgram (*Vigna mungo* L.) in Typic Haplustepts. *M.Sc. Thesis*, Maharana Pratap University Agriculture and Technology, Udaipur.

Meena, R. 2017. Response of greengram (*Vigna radiata*) to rock phosphate enriched compost on yield, nutrient uptake and soil fertility in Inceptisol. *International Journal of Chemical Studies* 5(2): 513-516.

Pandiyana, V., Balajib, C., Sarava, K., Shylajaa, S., Srinivasanc, S.G., Kiresee, G.R., and Maniveld, G. 2020. Effect of vermicompost on soil health and yield of sesamum (*Sesamum indicum L.). Journal of Soil Science and Plant Nutrition* 2: 311-316.

Panse, V.G. and Sukhatme, P.V. 1985. *Statistical Methods for Agricultural Workers*. ICAR, New Delhi.

Patil, P., Nagamani, C., Reddy, A.P.K. and Umamahesh, V. 2018. Effect of integrated nutrient management on yield attributes, yield and quality of pearlmillet [*Pennisetum glaucum* (L.) R. br. Emend. Stuntz]. *International Journal of Chemical Studies* 6(4): 1098-1101.

Patil, S.V., Halikatti, S.I., Hiremath, S.M., Babalad, H.B., Srinivasa, M.N., Hesbur, N.S. and Somanagouda, G. 2011. Effect of organic manures and rock phosphate on growth and yield of chickpea (*Cicer arietinum* L.) in Vertisols. *Karnataka Journal of Agricultural Sciences* 24(5): 636-638.

Paul, A.E. 2007. *Soil Microbiology, Ecology and Biochemistry*. 3rd edition. Academic Press. Jordan Hill, Oxford, UK.

Reddy, U. Vijayabhaskar, Reddy, G. Prabhakara, Reddy, M., Srinivasa and Kavitha, P. 2018 Effect of different nitrogen and phosphorus levels on growth and yield of maize during *kharif* season. *International Journal of Current Microbiology and Applied Sciences* 7(1): 3548-3555.

Shanti, K.V.P., Rao, M.R., Reddy, M.S. and Sarma, R.S. 1997. Response of maize (*Zea mays*) hybrid and composite to different levels of nitrogen. *Indian Journal of Agricultural Sciences* 67: 424-425.

Sreenivas, C., Muralidhar, S. and Rao, M.S. 2000. Vermicompost: a viable component of IPNSS in nitrogen nutrition of ridge gourd. *Annals of Agricultural Research* 21(1): 108-113.

Survase, D.N., Dongule, J.H. and Kadrekar, S.B. 1986. Growth, yield, quality and composition of groundnut as influenced by calcium, sulphur and boron in lateritic soil. *Journal of Maharashtra Agricultural Uni*versities 11: 49-51.

Verma, K., Bindra, A.D., Singh, J., Negi, S.C., Datt, N., Rana, U. and Manuja, S. 2018. Effect of integrated nutrient management on growth, yield attributes and yield of maize and wheat in maize-wheat cropping system in mid hills of Himachal Pradesh. *International Journal of Pure and Applied Bioscience* 6(3): 282-301.

Vimalan, B., Thiyageshwari, S., Balakrishnan, K., Rathinasamy, A. and Kumutha, K. 2019. Influence of NPK fertilizers on yield and uptake of barnyard millet grain (*Echinochloa frumentacea* (Roxb.) Link) in Typic Rhodulstalf soil. *Journal of Pharmacognosy and Phytochemistry* 8(2): 1164-1166.

Wafaa, W.M., El-Marakby, A.M., Abdel-Halim, A.A. and Afaf, M.T. 2002. Evaluation of performance and stability of some soybean genotypes under different environments. *Annals of Agricultural Sciences* 47: 621-640.

Zayed, G. and Abdel, M.H. 2005. Bioactive composts from rice straw enriched with rock phosphate and their effect on phosphorus nutrition and microbial community in rhizosphere of cowpea. *Bio-resource Technology* 96: 929-934.

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