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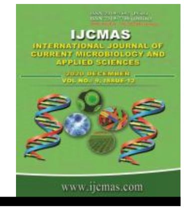

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Effect of Phosphorus, Zinc and Iron Levels on Growth and Yield of *Kharif* Maize (*Zea mays* L.)

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A B S T R A C T

A Field experiment was conducted during kharif season 2019-2020 at Crop Research Farm Department of Agronomy, SHUATS, Prayagraj, UP. To study the "Effect of Phosphorous, Zinc and Iron levels on growth and yield of kharif maize (*Zea mays* L.)". The experiment was laid out in Randomized block design with three replication and 9 treatments out of these application of Phosphorous 60 kg/ha + zinc 25 kg/ha + Fe 25 kg/ha in treatment 9 given maximum plant height (199.03cm), No. of leaves (12.73), Plant dry weight (176.23 g), No. of cob/plant (1.84), Cob length (20.14cm), No. of Grain row/cob (17.10), No. of grain/row (24.13), No. of grain/cob (412.73), Test weight (318.0g), Grain yield (2.77t/ha), Straw yield (5.23 t/ha), Harvest index (34.66%) and the same trend is follow on economic of the experiment i.e. the treatment 9 recorded maximum Gross return of Rs. 88330/ha, Net return Rs. 38632/ha and B:C 1.78. However, the treatment 8 (P 60 kg/ha + zinc 25 kg/ha + Fe 20 kg/ha) have the maximum CGR (14.56 g/m2 /day) and RGR (0.010 g/g/day).

Keywords

Kharif maize, Phosphorous, Zinc, Iron, growth, yield and economics

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Introduction

Maize (*Zea mays* L.) is the most important food crop after rice and wheat. It is a versatile emerging crop having wider adaptability to various Agro-climatic conditions. Globally maize occupies an area of 174.2 m ha with a production of 852 m t and productivity of 4890 kg/ha. In India, it occupies an area of 9.42 m ha with a production of 22.26 m t and an average productivity of 2583 kg/ha. In Karnataka, maize occupies an area of 1.38 m ha, with a production of 4.00 m t and average productivity of 2883 kg/ha. In India, maize is cultivated in the states of Andhra Pradesh, Karnataka, Bihar, Rajasthan, Madhya Pradesh, Gujarat, Chhattisgarh, Maharashtra, Tamil Nadu and Uttar Pradesh (Anon., 2014). In addition to high demand for macronutrients, micronutrients are required in relatively very small quantities for adequate plant growth and production, micronutrient deficiency may cause great disturbance in the physiological and metabolic processes involved in the plant. The application of micronutrient fertilizers as basal dose may not be reaching the crop requirement for root growth and nutrient use. The alternative approach is to apply these micronutrients through foliar sprays. Foliar application is the spraying of fertilizer solutions containing one or more nutrients on the foliage of growing plants. Several nutrient elements are readily absorbed by leaves when they are dissolved in water and sprayed on them. It is effective for the application of minor nutrients like iron, copper, boron, zinc and manganese. There are mainly three advantages of foliar application of fertilizers over soil application, utilization of applied quantity; about more than 90% fertilizer utilized by the plant when applied in foliar form, translocation within the plant. The Importance of Iron and Zinc Micronutrients are required in low quantities in a balanced human diet (GarcíaBañuelos *et al.,* 2014). They have a significant role in human physiological activities and metabolism (Goudia and Hash, 2015). In humans, Fe is found in red blood cells as a part of haemoglobin and is essential for O2 transport from lungs to tissues. As a part of cytochromes, it is essential for oxidative metabolism. Iron not immediately required by the body is stored in the liver as ferritin and hemosiderin (Abbaspour *et al.,* 2014). It 2 differs from other minerals because its balance in humans (except for women of reproductive age) occurs through absorption only, and there is no physical system for its excretion (Hurrell and Egli, 2010). Iron is the most important micronutrient, as it, being the main component of haemoglobin, myoglobin, and cytochromes, is involved in several metabolic reactions, such as energy production, immune defence, and thyroid function (Frossard *et al.,* 2000). It is the main component of various hemi and nonheme Fe enzymes and carriers, such as cytochromes and ferredoxins. Cytochromes are respiratory electron carriers, whereas ferredoxins are involved in N fixation, photosynthesis, and electron transfer (Frossard *et al.,* 2000; Fageria *et al.,* 2012). The other important functions of enzymes that contain Fe are the formation of bile acids and steroid hormones in the liver and controlling of signals in some neurotransmitters, such as serotonin and dopamine systems in the brain (Kumar *et al.,* 2015) In humans, Zn is mostly present in bones and skeletal muscles. It is responsible for the efficient functioning of >300 enzymes and acts as a stabilizer and protects membrane structure and cell components (Babu *et al.,* 2013; Kumar *et al.,* 2015). Biochemically, it is an important part of Zn-dependent enzymes and plays a significant role in synthesis and degradation of lipids, proteins, nucleic acid, and carbohydrates. It has structural and functional roles in various enzymatic mechanisms that are involved in gene expression (Frossard *et al.,* 2000; White and Broadley, 2009), cell division and growth, immune response, and reproductive functions (Cakmak, 2008; Thakur *et al.,* 2015). Zinc is a major component of many dehydrogenases, proteinases, and peptidases (e.g., carbonic anhydrase and alcohol dehydrogenase) (Fageria *et al.,* 2012). Principal cereals, tubers, legumes, and starchy roots are chief sources of Zn in low-income populations. However, Zn from these sources either is low in quantity or has low bioavailability. Cereals, such as maize, provide 50% of the Fe absorbed from foods consumed by poor people. Therefore, by increasing Fe and Zn contents of food crops, total uptake may be enhanced significantly (Kumar *et al.,* 2015). About 95% of the foliar fed nutrient solution can be found in the smallest root within 60 minutes, if conditions are optimum and foliar fertilizer use efficiency in sandy loam soils is up to 20 times more effective when compared to soil applied fertilizers. The availability of macro and micronutrients added to the soil will be affected by soil environmental factors. Foliar application technique is a particular way to supply macro and micro-nutrients which avoids these factors and results in rapid absorption. 3 Numerous studies confirmed positive response for the foliar application with the complete foliar fertilization in wheat (Ahmed and Ahmed, 2005). Hence, an attempt was made to know the effect of foliar application of micronutrients on growth, yield and nutrient uptake of maize. Crops grown in arid or semi-arid regions are mostly exposed to low soil fertility and exhibit multiple nutrient deficiencies due to low organic matter and alkaline calcareous nature that limit the crop production (Rafique *et al.*, 2006). The prime reason of this deficiency is the unavailability of irrigation water to apply the Most research on soil and foliar application of zinc focused on alleviating its deficiencies, particularly on wheat and rice cultivated in semiarid or arid regions of the world (Alloway, 2004; Cakmak, 2008). Maize was recognized by farmers for a long time as a crop of high response to zinc supply. In temperate regions, due much shorter vegetation and low temperatures prevailing at early stages, maize growth appears to be highly sensitive to many external and internal stresses, which in turn induce grain yield reduction (Leach and Hameleers, 2001; Subedi and Ma, 2009). It was recently documented that zinc foliar application is a simple way for making quick correction of plant nutritional status, as reported for wheat (Erenoglu *et al.*, 2002) and maize (Grzebisz *et al.*, 2008). Based on recent investigations related to factors limiting maize yielding physiology as well as grain yield, a hypothesis was formulated that the external supply of zinc boosts processes responsible for the yielding potential of maize nutrients to crop plants under field conditions in rainfed regions. Secondly, most of the Pakistani farmers do not apply micronutrient especially Zn and B (Kanwal *et al.*, 2010) that lead to their deficiency in soil and causes yield reduction. Micronutrient deficiencies attributable to malnutrition have irreversible and long-term negative effects on human health (Vasconcelos *et al.*, 2017). Two-thirds of all mortality among children younger than 5 years is attributable to micronutrient deficiencies (Welch and Graham, 2004). The World Health Assembly is aiming to reduce the number of stunted children due to malnutrition by 40% in 2025. It was suggested that mainstreaming nutrition in agricultural programs in regions like SSA would be the best strategy to eliminate malnutrition (Swaminathan, 2012). Many populations, particularly in low-income countries, are deficient in Zn, Fe, I, Se, and Co (Welch, 2008). More than two billion people around the world are victims of hidden hunger (Garg *et al.,* 2018), including Fe and Zn deficiency, particularly in developing countries (Welch and Graham, 2004; Goudia and Hash, 2015). Deficiencies of Zn and Fe rank fifth and sixth among the top 10 most important risk factors responsible for illnesses and diseases in developing countries (Fageria *et al.,* 2012). Iron is critical for human health because its deficiency can be life threatening. It is the most common mineral deficiency in the world (Ghandilyan *et al.*, 2006; Chakraborti *et al.*, 2011). Iron deficiency is widespread in developing countries because of lack of consumption of animal products (which can enhance nonheme Fe absorption and provide highly bioavailable heme Fe) and reliance on cereals and legumes as basic staple foods. Such foods are deficient in bioavailable Fe because of the presence of phytic acid and some polyphenols (Bouis 2002; Tako *et al.*, 2016). Anaemia caused by Fe deficiency affects 800 million women and children in the world (WHO, 2015). The chance of developing Fe deficiency is 40% in preschool children, 30% in menstruating girls and women, and 38% in pregnant women (Pasricha *et al.*, 2013). Maternal and perinatal death and loss of cognitive skills, growth, reproduction, and physical activity, mental retardation, weak immune system, and low work capacity are major threats of Fe deficiency. Iron deficiency effects have recently been effectively separated on the basis of age, sex, race, socioeconomic rank, and regional differences (Gibson, 2007;).

Currently, biomarkers such as serum ferritin, transferrin saturation, free red blood cell protoporphyrin, and Creative protein are used to evaluate the occurrence of Fe deficiency. Zinc deficiency is a vital threat to world agriculture and human health, particularly in arid and semiarid zones of the globe. Zinc deficiency affects 17% of the world's population, which is about two billion people. It causes reduced growth and development, depression, digestive system problems, anorexia, and changed reproductive biology signal transduction, gene expression, apoptosis, cell development, and cell replication (Ortiz-Monasterio *et al.,* 2007). Approximately 800,000 child deaths throughout the world per year are caused by Zn deficiency (Ortiz-Monasterio *et al.,* 2007). The chance of growth inhibition of children under 5 yr, attributable to Zn deficiency, is 29% in South Asia and 25% in SSA (Harvest Plus, http://www.harvestplus.org/node/634). Zinc deficiency affects people of all ages, but new born babies, young children, and pregnant and lactating women are more frequently affected. It has a lethal effect on human health that varies with age for example, diarrhoea, skin inflammation, and neurobehavioral complaints are common in babies (Dassoni *et al.,* 2014), whereas young children have skin changes, reduced taste perception, growth delay, and recurring infections. Elderly people are also at risk of Zn deficiency because of a reduced ability to absorb Zn in old 5 age. In the United States, 30% of elderly people are Zn deficient, which contributes to prolonged nonhealing leg ulcers and recurring infections (Brown *et al.,* 2004; Gibson, 2012). Modern approaches to overcome Zn deficiency include supplementation, fortification, food diversification, and biofortification. Zinc supplementation is suitable for treatment of severe diarrhoea, and to avert inhibited growth, diarrhoea, pneumonia, and death in children that are severely affected. Zinc-fortified food, such as muesli, is recommended for urban families, whereas food diversification and biofortification are appropriate for rural families (Gibson, 2012; García-Bañuelos *et al.,* 2014)

Considering the above facts, the present study aimed to investigate the effect of Phosphorous, Zinc and Iron levels, with the hypothesis that whether they can enhance the yield and net return of kharif maize crop. Therefore, the objectives are to find out the effect of different level of phosphorous zinc and iron on growth and yield attributes of maize crop and to find out the economics of different treatments.

Materials and Methods

The experiment was conducted during the kharif season of 2019 at the Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj. The Crop Research Farm is situated at 250 57'N latitude, 870 19'E longitude and at an altitude of 98 m above mean sea level. This area is situated on the right side of the river Yamuna and by the opposite side of Prayagraj City. Prayagraj has a subtropical and semi-arid climatic condition, with both extremes of temperature, i.e. winter and summer. The soil of the experimental field constituting a part of central Gangetic alluvium is neutral and deep. Pre-sowing soil samples were taken from a depth of 15 cm with the help of an auger. The composite samples were used for the chemical and mechanical analysis. The soil was sandy loam in texture, low in organic carbon (0.28%) and medium in available nitrogen (225 kg/ha), phosphorus (19.50 kg/ha) and low in potassium (92.00 kg/ha).

The experiment was laid out in Randomized Block Design (RBD) and replicated thrice.

There were 9 treatments, comprised of three factors, Factor 1: Levels of Phosphorous application as foliar at 1. 45 kg/ha and 2. 60 kg/ha, Factor 2: Levels of Zinc application as foliar at 1. 20 kg/ha and 2. 25 kg/ha, Factor 3: Levels of Iron application as foliar at 1. 20 kg/ha and 2. 25 kg/ha. Allocation of the treatment was done by the randomization following Fisher and Yates random number table. Multicolour maize variety was used in the experiment. The data were recorded on 5 randomly selected plants from each plot for growth, yield and yield attributes. The growth attributes studied were plant height (cm), number of leaves/plant, plant dry weight (g/plant), crop growth rate (g/m2/day), relative growth rate (g/g/day).Yield attribute studied were no. of cob/plant, cob length(cm), no. of row/cob, no. of grain/row, no. of grain/cob, test weight (g), grain yield (t/ha), stover yield (t/ha), harvest index (%). Along with growth, yield and yield attribute, economics of rice was also studied, which include gross return (₹ /ha), net return (₹ /ha), and benefit cost ratio to find out which treatment is more economical to farmers.

The experimental field was thoroughly ploughed and harrowed and brought to fine tilth. Stubbles and weeds were picked up from the field and the land was levelled with the help of rake and the plots were demarcated according to layout. The dose of soil application N, P_2O_5, K_2O along with basal application of $ZnSO_4$ and $FeSO_4$ for maize was worked out according to the present recommendation of maize hybrids in Prayagraj District. The 100% NPK dose in kg/ha worked out was 120:60:60 for maize crop. The doses for phosphorous, zinc and iron were farmed by applying $ZnS0_4$ at 0.5% +1.0%, $FeS0_4$ at 0.5% +1.0% and foliar spray of soluble boron at 0.5% + 1.0% respectively. Fertilizer application was made as per the treatments, full dose of phosphorus, potash and half dose of nitrogen were applied at sowing as basal application, the remaining dose of nitrogen was top dressed at 30 DAS and 60 DAS depending upon the occurrence of rains. Foliar spray of zinc, iron and boron were mixed with water and applied at 30DAS and 60DAS. The average height of plants was recorded at an interval of 20 DAS, the height of plant was measured from the base of the plant up to the highest point of the arch of the uppermost leaf whose tip is pointing down. Number of green leaves/plants was also recorded at regular intervals of 20, 40, 60, 80 and 100 DAS from the tagged plants of each plot. Dry weight of plants were recorded with roots by uprooting three plants randomly from each plot, these plants were first air dried then wrapped with paper and then kept in oven for oven drying at 70˚C for 24- 48 hours, the dry weight of samples were recorded, averaged and expressed as g/plant, For calculating number of cobs/plant, cobs of tagged plants were counted, the average value for each treatment was calculated thereafter. The total number of seed rows/cob from the five fresh cobs was counted and the average was expressed as number of seed rows/cob. Length of the individual cob from selected five plants was measured from the base to the tip of the cob and expressed in centimetres (cm). Five dried cobs were selected at random from the selected plants and their weight was taken. The average was worked out and expressed as weight of cob/plant (g). Number of grains/cobs was counted from cob of five selected plants. Cob of harvested plants of net plot area after proper sun drying were separated from plants, de-husked and shelled with the help of cob sheller. The produce was cleaned, weighed and expressed in terms of grain kg/ha. Stover yield was obtained by subtracting the grain yield/plot from the respective biological yield/plot and finally expressed in terms of stover yield kg/ha. Cost of cultivation, gross return, net return and Benefit Cost Ratio were worked out to evaluate the economics of each treatment, based on the existing market prices of inputs and output. Benefit: cost ratio was calculated by dividing the net returns from total cost of cultivation. The benefit cost ratio was calculated by using following expression: Net returns (₹ /ha) ÷ Cost of cultivation (₹ /ha). The data obtained from this study were analysed statistically using the F–test, as per the procedure given by Gomez and Gomez (1984) and 5% level of significance was used to compared the differences among the treatment. The treatment differences that were non-significant at five per cent were denoted as NS.

Results and Discussion

Growth attributes

At 100 DAS significant and maximum plants hight (199.03cm) respectively was observed in treatment 9 (P 60 kg/ha + zinc 25 kg/ha + Fe 25 kg/ha), however except treatments 1, 2 and 5 all are found to be at par with this. Improvement in plant height with higher phosphorus levels over and above 40 kg P2O5 ha-1 (P2) might be attributed to the fact that phosphorus is a constituent of nucleic acids, phospholipids, coenzymes and most importantly ATP. It activates coenzymes for amino acid production used in protein synthesis which might have resulted in better plant height. Similar results were obtained by Gemechu (2011) and Reddy *et al.,* (2018)

At 100 DAS the significant and maximum No. of leaves/plant (12.13) was found in treatment 9 (P 60 kg/ha + zinc 25 kg/ha + Fe 25 kg/ha). However, treatment 3, 4 and 5 was found to be at par with this. The maximum number of leaves per plant was due to availability of adequate phosphorus at higher levels of application which encouraged leaf expansion and growth. Similar observations were also recorded by Gemechu (2011) and Araei and Mojaddam (2014) (Table 1).

Table.1 Effect of phosphorous, zinc and iron levels on growth attributes of maize

Treatment Details	At 100 DAS			80-100 DAS	
	Plant height (cm)	No. of Leaves /plant	Plant dry weight (g)	CGR ($g/m^2/day$)	RGR (g/g/day)
1. Control (120:60:60 soil application of NPK)	185.44	11.33	154.96	12.05	0.010
2. P 45 kg/ha + Zinc 20 kg/ha + Iron 20 kg/ha	186.22	11.66	163.56	14.07	0.011
3. P 45 kg/ha + Zinc 20 kg/ha + Fe 25 kg/ha	**194.24**	**12.40**	165.03	13.80	0.010
4. P 45 kg/ha + Zinc 25 kg/ha + Fe 20 kg/ha	**194.66**	11.76	166.10	12.25	0.009
5. P 45 kg/ha + zinc 25 kg/ha + Fe 25 kg/ha	184.46	**12.46**	161.36	13.71	0.011
6. P 60 kg/ha + zinc 20 kg/ha + Fe 20 kg/ha	**190.32**	11.40	167.43	12.26	0.009
7.P 60 kg/ha + zinc 20 kg/ha + Fe 25 kg/ha	**196.72**	11.36	169.90	12.93	0.009
8.P 60 kg/ha + zinc 25 kg/ha + Fe 20 kg/ha	**190.50**	11.66	**174.93**	14.56	0.010
9. P 60 kg/ha + zinc 25 kg/ha + Fe 25 kg/ha	199.03	12.73	176.23	12.25	0.009
F test	S	S	S	NS	NS
SE(m)	3.36	0.35	1.75	1.78	0.001
CD (P=0.05)	9.86	1.05	5.30	-	-

Table.2 Effect of phosphorous, zinc and iron levels on yield attributes and yield of maize

Treatments	Number of Cobs/Plant	Number of Rows/ Cob	Number of Grains/ Cob	Number of Grains/ Row	Test Weight (g)	Grain Yield (t/ha)	Stover Yield (t/ha)	Harvest Index (%)
1. Control (120:60:60 soil application of NPK)	1.06	12.22	185.87	15.20	254.33	1.97	4.23	31.73
2. P 45 kg/ha + Zinc 20 kg/ha + Iron 20 kg/ha	1.20	13.99	248.34	17.73	268.66	2.34	4.63	33.62
3. P 45 kg/ha + Zinc 20 kg/ha + Fe 25 kg/ha	1.26	14.32	262.50	18.33	278.00	2.42	4.71	33.97
4. P 45 kg/ha + Zinc 25 kg/ha + Fe 20 kg/ha	1.40	14.44	280.33	19.40	281.00	2.47	4.86	33.83
5. P 45 kg/ha + zinc 25 kg/ha + Fe 25 kg/ha	1.13	12.66	206.87	16.33	262.66	2.29	4.53	33.64
6. P 60 kg/ha + zinc 20 kg/ha + Fe 20 kg/ha	1.46	15.11	326.53	21.60	288.66	2.51	4.89	33.93
7. P 60 kg/ha + zinc 20 kg/ha + Fe 25 kg/ha	1.66	15.33	354.01	23.06	300.33	2.59	5.04	33.93
8. P 60 kg/ha + zinc 25 kg/ha + Fe 20 kg/ha	1.73	16.66	386.57	23.20	310.33	2.65	5.18	34.03
9. P 60 kg/ha + zinc 25 kg/ha + Fe 25 kg/ha	1.86	17.10	412.76	24.13	318.00	2.77	5.23	34.66
F test	S	S	S	S	S	S	S	NS
SE(m)	0.09	0.41	11.68	0.31	4.78	0.02	0.17	0.76
CD (P=0.05)	0.28	1.26	34.34	0.95	14.47	0.07	0.53	-

Table.3 Effect of phosphorous, zinc and iron levels on economics of maize

Treatment No.	Cost of cultivation(INR/ha)	Gross return(INR/ha)	Net return(INR/ha)	B:CRatio
1. Control (120:60:60 soil application of NPK)	46323.00	63330.00	17007.00	1.37
2. P 45 kg/ha + Zinc 20 kg/ha + Iron 20 kg/ha	47616.75	74830.00	27213.25	1.57
3. P 45 kg/ha + Zinc 20 kg/ha + Fe 25 kg/ha	47916.75	77310.00	29393.25	1.61
4. P 45 kg/ha + Zinc 25 kg/ha + Fe 20 kg/ha	47991.75	78960.00	30968.25	1.65
5. P 45 kg/ha + zinc 25 kg/ha + Fe 25 kg/ha	48291.75	73230.00	24938.25	1.52
6. P 60 kg/ha + zinc 20 kg/ha + Fe 20 kg/ha	49023.00	80190.00	31167.00	1.64
7. P 60 kg/ha + zinc 20 kg/ha + Fe 25 kg/ha	49323.00	82740.00	33417.00	1.68
8. P 60 kg/ha + zinc 25 kg/ha + Fe 20 kg/ha	49398.00	84680.00	35282.00	1.71
9. P 60 kg/ha + zinc 25 kg/ha + Fe 25 kg/ha	49698.00	88330.00	38632.00	1.78

At 100 DAS the significant and maximum plant dry weight (176.23 g) was found in treatment 9 (P 60 kg/ha + zinc 25 kg/ha + Fe 25 kg/ha). However, treatment 8 was found to be at par with this. Application of phosphorus at 60 kg / ha (P2) resulted in higher dry matter, which was comparable to 80 kg / ha (P3) and significantly superior to 40 kg / ha (P1). It seems the reason is increase in leaf area, photosynthesis improvement resulting in higher dry matter. Araei and Mojaddam (2014) also recorded the highest dry weight

and leaf area of maize by applying 60 kg P ha1 over 0 and 90 kg/ ha P2O5Reddy *et al.*, 2018. For GGR and RGR, there is no significant difference among the treatment combinations.

Post-harvest observation

The significant variation in No. of cob/plant was due to different treatment combination the maximum No. of cob/plant 1.86/plant was found in treatment 9 (P 60 kg/ha + zinc 25 kg/ha + Fe 25 kg/ha). However, treatment 7 and 8 was found to be at par with the treatment.

The significant and maximum Cob length (20.14cm) was found in treatment 9 (P 60 kg/ha + zinc 25 kg/ha + Fe 25 kg/ha). Which was found to be most significant.

The significant and maximum No. of row/cob (17.10) was found in treatment 9 (P 60 kg/ha + zinc 25 kg/ha + Fe 25 kg/ha). However, treatment 8 was found to be at par with this.

The significant and maximum No. of grain/row (24.13) was found in treatment 9 (P 60 kg/ha + zinc 25 kg/ha + Fe 25 kg/ha). However, treatment 8 was found to be at par with this. The significant and maximum No. of grain/cob (24.13) was found in treatment 9 (P 60 kg/ha + zinc 25 kg/ha + Fe 25 kg/ha) however treatment 8 was found at par with this.

Application of phosphorus at 60 kg / ha (P2) resulted in higher dry matter, No. of grain/cob, Cob length, and No. of cob/plant which was comparable to 80 kg / ha (P3) and significantly superior to 40 kg / ha (P1).It seems the reason is increase in leaf area, photosynthesis improvement resulting in higher dry matter. Araei and Mojaddam (2014) also recorded the highest dry weight and leaf area of maize by applying 60 kg P ha1 over 0 and 90 kg/ ha P2O5 Reddy *et al.*, 2018

The significant and maximum Test weight (318.0g) was found in treatment number 9 (P 60 kg/ha + zinc 25 kg/ha + Fe 25 kg/ha). However, treatment 8 was found to be at par with this. The significant and maximum Grain yield 2.77t/ha was found in treatment number 9 (P 60 kg/ha + zinc 25 kg/ha + Fe 25 kg/ha). However, treatment 8 was found to be at par with this.

The significant and maximum straw yield 5.22t/ha was found in treatment number 9 (P 60 kg/ha + zinc 25 kg/ha + Fe 25 kg/ha). However, treatment 8 was found to be at par with this. The significant and maximum Harvest index 34.66 % was found in treatment 9 which was most significant among all treatment (Table 2).

Maize supplied with 60 kg/ha P_2O_5 (P2) resulted in higher grain yield, which was however statistically on par with 45 kg/ha P_2O_5 (P3). Significantly lowest grain yield was obtained with 40 kg/ha P_2O_5 (P1) in the first year. Similar trend was observed during the second year but all the three phosphorus levels recorded statistically on par values of grain yield.

Stover yield of maize increased significantly up to 60 kg/ha P_2O_5. Further increase in P from 60 to 80 kg /ha P_2O_5, decreased the stover yield. Higher straw yield at medium phosphorus level could be attributed to adequate and balanced nutrient supply over higher and lower levels. Similar results were obtained by Araei and Mojaddam (2014) and Nsanzabaganwa *et al.*, 2014.

Economics

The cost of cultivation is given in Table 3. and the variable Cost of cultivation is given in table 3. However, the total cost of cultivation varies between Rs. 46323 to Rs. 49698.

The maximum gross return Rs. 88330/ha was found in Treatment 9 (P 60 kg/ha + zinc 25 kg/ha + Fe 25 kg/ha) However the minimum Gross return Rs. 63330/ha was found in control plot. The maximum net return Rs. 38632/ha was found in Treatment 9 (P 60 kg/ha + zinc 25 kg/ha + Fe 25 kg/ha). The B:C ratio varies between 1.37 and 1.78 and the maximum B:C 11.78 was found in Treatment P 60 kg/ha + zinc 25 kg/ha + Fe 25 kg/ha).

From the one year experiment it can be concluded that treatment 9 (P 60 kg/ha + zinc 25 kg/ha + Fe 25 kg/ha) gave maximum Plant height, No. of leaves, Plant dry weight, No. of cob/plant, Cob length, No. of row/cob, No. of grain / row, No. o grain / cob, Test weight, Grain yield, Stover yield and Harvest index.

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