Effect of nitrogen, phosphorus and zinc fertilization on yield and quality of kharif fodder - A review

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ABSTRACT

Nutrient management is one of the most important factors in crop production. The review of knowledge regarding the use of optimum dose of nutrients especially nitrogen, phosphorus and zinc is of prime concern. The literature regarding effect of nitrogen, phosphorus and zinc on growth, yield and quality of kharif fodder is very scanty, therefore, findings of this paper and views of active investigators, theoreticians and practitioners on growth, yield and quality of kharif fodders viz. teosinite, maize, bajra and sorghum will be useful.

Key words: Kharif fodder, Nitrogen, Phosphorus, Quality, Yield, Zinc.

Effect of nitrogen: The growth and yield of a crop can be adversely affected by deficient or excessive supply of any one of the essential nutrients. However, in intensive agriculture nitrogen is the major nutrient which determining crop yield. Nitrogen plays an important role in plant growth as an essential constituent of cell components having direct effect on growth, yield and quality of crop. Black (1957) reported that plant growth is affected more due to deficiency of nitrogen than that of any other nutrient. Nitrogen fertilization of maize influences dry matter yield by influencing leaf area index, leaf area duration and photosynthetic efficiency (Muchow and Davis, 1988).

Growth and growth components: Growth components like plant height, number of leaves, stem diameter, leaf area of fodder maize influenced significantly by the application of nitrogen and phosphorus (Ayub et al. 2002). Similarly Grazia et al. (2003) from Buenos Aires Argentina observed significant difference in plant height, leaf width, leaf length, leaf area, ear diameter, biomass production and yield with application of nitrogen fertilizer. Hani et al. (2006) from Sudan reported that plant height, stem diameters, LAI (leaf area index) increased significantly with increase in levels of nitrogen from 0 to 80 kg N ha⁻¹. However 40 and 80 kg N ha⁻¹ remained at par with each other in fodder maize. While increasing nitrogen levels did not significantly affect number of leaves per plant. Application of 80 kg N ha⁻¹ produced significantly higher LAI (20.20) as compared to 40 kg N ha⁻¹ (16.78) and control (7.93). Onasanya et al. (2009) from southern Nigeria reported that application of 120 kg N ha⁻¹ + 0kg P ha⁻¹ and 60 kg N ha⁻¹ + 40 kg P ha⁻¹ significantly increased the growth and growth attributes of maize plant. Maximum and minimum leaf area and plant girth were found at 120 kg N ha⁻¹ and control respectively.

Valadabadi and Farahani (2010) from Iran reported that application of nitrogen fertilizer significantly affected the total dry weight (TDW), leaf area index (LAI), relative growth rate (RGR) and crop growth rate (CGR) of maize crop. The highest total dry weight (TDW) (1910 g.m⁻²), LAI (4.2), RGR (0.08 g.g.day⁻¹) and CGR (31.2 g.g.m⁻².day⁻¹) were obtained with application of 520 kg urea ha⁻¹, respectively. Sharifi and Teghizadeh (2009) reported that plant height increased with increase in levels of nitrogen application and maximum plant height (204.6 cm) was recorded at 240 kg N ha⁻¹. Similarly Sanjeev and Bangarwa (1997) also reported that plant height was maximum at highest levels of nitrogen.

Yield and yield attributes: Panchannathan et al. (1987) reported that application of 120 kg N ha⁻¹ recorded maximum number of grains per cob, cob length, cob girth and 1000 grain weight, which was at par with application of 180 kg N ha⁻¹ but significantly higher than 60 kg N ha⁻¹ and no nitrogen. Roy and Singh (1987) found that pop corn yield increased from 2.77 to 4.1 tonnes ha⁻¹ with increase in level of N from 40 to 100 kg ha⁻¹. In addition, the yield attributing characters such as number of cobs ha⁻¹ and grain weight per cob increased significantly with N application. Similarly Singh et al. (1982) found that increase in levels of nitrogen increased the grain

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yield significantly. The highest yield of 44.5 q per ha was obtained with 100 kg N ha\(^{-1}\). Singh et al. (1988) noticed that in teosinte, sudangrass and dinanath grass, both fresh herbage and dry matter yield increased significantly with increased in N application up to 100 kg ha\(^{-1}\). Further Singh et al. (1988) reported that the herbage yield of teosinte increased significantly with increase in N level of up to 100 kg N ha\(^{-1}\) from single cut and up to 150 kg N ha\(^{-1}\) under two-cut system. Lee and Seo (1988) reported that the dry matter yield of teosinte, sorghum-sudangrass and pearl millet increased significantly with increasing in level of N application up to 200 Kg N ha\(^{-1}\). Similarly Almodares et al. (2008) in Iran reported that total biomass yield of sorghum and sweet corn increased significantly with increase in levels of nitrogen fertilizer. Highest biomass yield (64.80 t/ha) was recorded at nitrogen (200 kg/ha urea) and lowest (55.50 t/ha) at (50 kg/ha urea). Khan et al. (1999) observed significant effects of NPK on plant height, number of cobs per pant, number of grains per cob, 1000 grain weight, weight and biological yield of maize. Similarly Sharar et al. (2003) at Faisalabad Pakistan reported that yield and yield attributing character like plant height, number of cobs per m\(^2\), number of grain per cob, 1000 grain weight, grain yield and harvest index were influenced significantly by different combination of nitrogen and phosphorus.

Siam et al. (2008) reported that increase in level of N up to 140 kg N/ha significantly increased plant height, fresh and dry weight, weight of leaf ear, ear weight, 100 grain weight, yield and N, P and K uptake of maize plant. Ayub et al. (2002) worked at Faisalabad Pakistan reported that green fodder yield, dry matter yield and dry matter percentage of fodder maize was significantly influenced by the application of nitrogen and phosphorus. Wadsworth (2002) reported that increased dry matter production with increased fertilizer application was due to the role of NPK in determining the use efficiency of sunshine by the increased biomass and any inadequacy of nitrogen reduce the sunshine use efficiency or ability to photosynthise. Rashid and Ryan (2004) at Faisalabad Pakistan revealed that maize crop fertilized with @ 250: 150: 100: 15 NPKS Kg\(^{-1}\) produced significantly more grain yield (8.52 t ha\(^{-1}\)), stover yield (12.08 t ha\(^{-1}\)), and (NE) nutrient efficiency (10.46) than other treatments. Sharifi and Taghizadeh (2009) reported that yield and yield attributes of maize hybrid were significantly affected by nitrogen levels. The highest grain yield (7.43 ton ha\(^{-1}\)), number of kernel per ear (668), number of grains rows (18.6), number of grain per ear row (37), ear diameter (35 mm), cob length (167.4 mm), was recorded with the application of highest levels of nitrogen (240 Kg N ha\(^{-1}\)). Similarly Reddy and Bhanumurthy (2010) at Rajendra Nagar (A.P.) India reported that forage maize grown for green fodder, dry fodder and grain purpose gave significantly higher grain yield (3.9 t ha\(^{-1}\)), stover yield, (8.3 t ha\(^{-1}\)) by the application of 240 kg N ha\(^{-1}\) in three splits (0, 30 and 70 DAS).

**Quality and quality attributes:** Abichandani et al. (1970) at I.G.F.R.I. Jhansi, U.P. reported that crude protein, crude fibre, ether extract, and calcium content of teosinte increased with increase in level of nitrogen from 0 to 90 kg N ha\(^{-1}\). Walli and Relwani (1970) at NDRI, Karnal, Haryana recorded that production of crude protein, ether extract, crude fibre, calcium and phosphorus were linearly correlated with nitrogen application. Cox et al. (1993) conducted research at New York on forage maize and revealed that NDF (Neutral Detergent Fibre) and ADF (Acid Detergent Fibre) decrease linearly with increase in N levels. However DM intake and in vitro DMD digestibility and N content increased with each additional increment of N. The best forage quality was obtained with application 225 kg N ha\(^{-1}\). Ayub et al. (2002a) reported that quality parameter of forage sorghum such as crude protein, ether extract, and ash content increased with increase in level of nitrogen application. Maximum and minimum crude protein and ether extract were recorded at 150 kg N ha\(^{-1}\) and control respectively. However NDF and ADF content decreased with increase in nitrogen levels. Maximum and minimum NDF and ADF were found in control and 150 kg N ha\(^{-1}\). Singh et al. (1988) reported that in teosinte fodder, crude protein and digestible dry matter yields increased significantly with increase in level of N fertilization up to 150 kg N ha\(^{-1}\).

Eltelib et al. (2006) reported that increasing the level of nitrogen from 40 to 80 Kg per hectare significantly improved the protein content of forage maize, but crude fibre content was not significantly affected. The crude protein content of 9.06% and 3.67% was recorded at 80 kg N/ha and control, respectively. Almodares et al. (2008) from Iran reported that growth and quality parameters in sweet sorghum like stem height (12.65%), stem fresh weight (24.57%), total fresh weight (78.22%), total sugar (39.25%), sucrose content (9%) and juice extract (34.96%) increased significantly with increase in level of urea from 0 to 180 kg ha\(^{-1}\). Ayub et al. (2000) also reported that maximum crude fibre (29.52%) and ADF content was obtained where no N was applied. Reddy and Bhanumurthy (2010) reported that in forage maize, N uptake (273.4 kg ha\(^{-1}\)) and crude protein yield (1695 kg ha\(^{-1}\)) were significantly higher by the application of 240 kg N ha\(^{-1}\) in three splits (0, 30 and 70 DAS). Similarly Lee and Seo (1988) reported that in teosinte, sorghum, sudan-grass and pearl-millet, the percentage of crude protein was increased with increasing level of N.
Carpici et al. (2010) reported that increasing the rate of nitrogen significantly increased crude protein content and neutral detergent fibre (NDF) in forage maize. However Acid Detergent Fibre (ADF) was not influenced by nitrogen levels. Singh et al. (2010) reported a significant increase in carbohydrate, sugar, starch, protein, N, P and K content and uptake with increase in N+P+K from 120+25.8+49.8 to 60+12.9+24.9 ha⁻¹. Shezhad et al. (2012) reported that application of 180 Kg N ha⁻¹ significantly enhanced quality of maize fodder. Maximum dry matter (31.92%), crude protein (10.52%), crude fat (2.82%), crude fibre (31.77%) and ash content (10.54%) was observed with the application of 180 kg N ha⁻¹. Similarly Ayub et al. (2002) worked at Faisalabad Pakistan reported that quality parameters of fodder maize such as crude protein, crude fibre and ash content were influenced significantly by the application of N and P fertilizers.

**Economics of fodder production:** Parodhan et al., (2007) reported that application of 125 kg N ha⁻¹ was economic optimum dose of nitrogen for baby corn production. Colyer and Korth (1968) found that the economic optimum dose of nitrogen for maize was 120 kg ha⁻¹. Similarly, Sahoo and Panda (1999) reported that for higher yield and net profit, baby corn should be fertilized with 120 kg N ha⁻¹. Reddy and Bhanumurthy (2010) at Rajendra Nagar (A.P .) India reported that forage maize grown for green fodder, dry fodder and grain purpose gave significantly higher net returns (Rs. 24,509 ha⁻¹) by the application of 240 kg N ha⁻¹ in three splits (0, 30 and 70 DAS). Singh et al. (2011) from Wadura (Kashmir), reported that application of 120 Kg N ha⁻¹ markedly improved crop profitability (Rs. 635.9 ha⁻¹ day), Net returns (Rs. 65.49×10³ ha⁻¹) and net returns per rupee invested (Rs. 6.35) over preceded levels. However it was at par with 150 kg N ha⁻¹.

**EFFECT OF PHOSPHORUS:** Phosphorus is considered as an essential nutrient for growth and development of plant. It is an integral part of nucleic acid and essential for cellular respiration and metabolic activity. It is involved in many enzymatic reaction, CO₂ fixation, sugar metabolism, energy storage and transfer. Judicious use of phosphorus will help in increasing per hectare yield (Demkin and Ageev, 1990). Therefore, it is imperative to study the effects of phosphorus on kharif teosinte fodder yield. P deficiencies occur in animals when forages containing 0.10-0.12 % P are fed (Black et al., 1949). It is one of the major essential plant nutrients after nitrogen and is the second most deficient plant nutrient (Munir et al., 2004).

**Growth and growth components:** Bothe et al. (2000) reported that the tallest plant were found at 75 kg P₂O₅ ha⁻¹ over a range of P level from 0-75 kg P₂O₅ ha⁻¹. Maqsood et al. (2001) reported that plant height was affected by various levels of nitrogen and phosphorus. Maximum plant height was obtained in plots treated with 150:120:60 N: P: K Kg ha⁻¹. Similarly Issa Piri (2012) reported that application of phosphorus fertilizer with micro nutrient foliar application had significant effect on plant height. Alias et al. (2003) reported that growth components of maize such as leaf area per plant, was significantly increased by increasing levels of phosphorus. Roy and Khandaker (2010) in Bangladesh reported that application of phosphorus @ 80 kg TSP ha⁻¹ has significant effect on plant height of sorghum at 60 DAS as compared to control and 40 kg TSP ha⁻¹.

**Yield and yield attributes:** Bhagwan et al. (1997) reported that DM yield increased with the increasing level of P up to 60 kg P/ha.. Maqsood et al. (2001) at Faisalabad Pakistan reported that yield and yield attributes of maize like, number of cobs per plant, average grain weight (1000-grain weight), grain yield were significantly affected by application of nitrogen and phosphorus. Maximum number of cobs and grain yield was observed in treatment of 150:120:60 kg NPK ha⁻¹ wherever average grain weight was higher in treatment of 120:100:60 NPK ha⁻¹. Similarly Alias et al. (2003) reported that yield components of maize such as number of grain per cob and 1000 grain weight was significantly increased by increasing levels of phosphorus. Khan et al. (2005) from Multan Pakistan Observed that plant height, number of cobs per plant, number of grain rows per cob, number of grains per cob, grain weight per cob, 1000-grain weight, stalk and grain yield increased significantly with phosphorus application. There was no significant effect of phosphorus on harvest index had observed. Maize plant fertilized with 75 Kg P₂O₅ ha⁻¹ had grain weight per cob (113.50 g), number of grains per cob (434), cob weight and 1000-grain weight (133 g) over other levels. Maximum plant height (208.9 cm) and number of cobs per plant (1.90) were recorded in maize plants fertilized with 100 kg P₂O₅ ha⁻¹ the whereas maximum number of grain rows per cob (14.88) was produced in maize plants fertilized with 50 kg P₂O₅ ha⁻¹. Kumar et al. (2007) at Dharwad (Karnataka) reported that growth parameters of sweet corn viz., leaf area index and total dry matter production were influenced favourably with increasing levels of NPK application. The highest leaf area index was recorded in treatment which received 100% RDN + 100% RDP + 125% RDK (0.63, 3.35 and 3.05 at 30, 60 DAS and at harvest, respectively). The lowest leaf area index was recorded in treatment which received 50% RDN + 75% RDP + 75% RDK. Kumar et al. (2007) at Dharwad (Karnataka) reported that yield and yield components of sweet corn were influenced
favourably with increasing levels of NPK application. A reduction in N application below 75 per cent of recommended dose of nitrogen (RDN) reduced the yield parameters and fresh cob yield significantly. Total dry matter production of sweet corn increased with increasing levels of NPK at all growth stages of crop. The treatment which received 25% more K along with RDN and RDP recorded highest number of cobs per plant (2.26). The lowest number of cobs per plant (1.53) was recorded in treatment of 50% RDN + 75% RDP + 75% RDK. Roy and Khandaker (2010) in Bangladesh observed that phosphorus application had significant effect on green forage yield and influenced by increasing the level of phosphorus at both cutting. In second cutting, green matter yield was highest (6.08 MT ha⁻¹) at the level of 80 kg TSP ha⁻¹ while the lowest yield (2.66 MT ha⁻¹) was in control. Similarly in third cutting, the highest yield was found in 80 kg TSP ha⁻¹ and the lowest 1.15 MT ha⁻¹ in 40 kg TSP ha⁻¹. Similarly Khot et al. (1997) reported that the green forage yield increased significantly with increasing levels of P fertilizer. Issa Piri (2012) reported that application of phosphorus fertilizer with micro nutrient foliar application had significant effect on flag leaf length, grain weight and biological yield of sorghum.

**Quality and quality components:** Elsokkoary et al. (1981) reported that phosphorus application generally increased the plant dry weight, phosphorus concentration in the whole plant and/or in different plant parts without being significantly affected by Zn. In the soils not treated with Zn, P additions increased Zn uptake by the plants. On the other hand, in the soils treated with Zn, P additions decreased Zn uptake. Chatterjee et al. (1990) observed that P deficiency causes increase in protein solubility, ribonuclease, acid phosphatase, and polyphenol oxidase activity, which were intensified by a combined deficiency of B and P. A result was also found by Cecato et al. (2004) who reported that P content showed an increasing with increasing levels of phosphorus. Awk and Abbasi (2000) found that increasing levels of P fertilizer increased phosphorus uptake. Similar responses were also found by Hirpara et al. (1992) who reported that P uptake of Sorghum fodder increased with increasing levels of P fertilizer. Chaudhary et al. (2003) observed that P contents in maize fodder increased significantly with increasing soil solution P levels in all the soil series and reported that the critical phosphorus concentration ranged from 0.22 to 0.26 % for 40-60 cm tall maize plants. Roy and Khandaker (2010) in Bangladesh reported that application of phosphorus fertilizer had significant effect on quality parameter of sorghum fodder like dry matter content, crude protein, ether extract, ash content, crude fibre and P content. Highest DM content (15.82g/100g) was found with the application of 40 kg TSP/ha followed by 0kg, 80 kg and 120 kg TSP/ha. There was a significant difference in CP content in first and third cutting. The results are in contrast with the findings of Keshwa and Jat, (1992) who reported that CP content of summer pearl millet increased significantly with the increasing level of P fertilizer application. Singh et al. (2010) reported that increase in level of NPK resulted in an increase in carbohydrate, starch, protein and reduction in sugar content. The crude protein content of baby corn improved significantly as a result of increase in total nitrogen uptake. Rashid and Iqbal (2012) reported that yield of maize fodder increased with increasing rate of phosphorus up to 53 kg ha⁻¹. Quality traits (P concentration, dry matter, crude protein, crude fibre, ash content) improved with the application of 57 kg phosphorus ha⁻¹. Phosphorus application showed non-significant effect on NDF and ADF content. Similarly Chand et al., (1992) reported that ADF and NDF contents of sorghum fodder did not change significantly with P application. However increase in crude fibre contents was due to more dry matter accumulation with P application.

**ECONOMICS:** Rasheed et al. (2004) from Pakistan found that the crop fertilized @ 250:150:100:15 kg N:P:K:S ha⁻¹ gave significantly the maximum net income (Rs. 48690.5 ha⁻¹ with benefit: cost of (2.98) and was followed by 250:150:100:15 kg N:P:K:S Mg ha⁻¹ (Rs. 47288.5 ha⁻¹ with benefit: cost of 2.81 and 250:50:100 kg N:P:K ha⁻¹ (Rs. 39586.7 with benefit: cost of 2.73) which was significantly different from each other. Rashid et al. (2004) at Faisalabad (Pakistan) reported that the crop fertilized with 250: 150: 100: 15 NPKS Kg⁻¹ gave the maximum net income of Rs. 48690.5 per ha with benefit cost ratio of 2.98. Dadarwal et al. (2009) observed an increase in net returns and B: C ratio with increasing dose of fertilizer application. They obtained net returns of 12145, 16814 and 18910 and B:C ratio of 2.03, 2.36 and 2.47 with rates of 120 : 40 : 30 Kg NPK per hectare, 150 : 50 : 37.5 kg NPK per hectare and 180 : 60 : 45 kg NPK per hectare, respectively. Singh et al. (2010) reported that net return and B : C increased significantly with successive increase in fertility level Net return and B : C were highest (Rs. 123,989 and 3.97) with the application of 180+38.7+74.7 kg N+P+K per hectare of baby corn. Rakib et al. (2011) reported the cost of cultivation Rs 15166, 14318 and 13471, gross returns Rs 51780, 36960, and 27720, and net returns Rs 36614, 22642 and 14249 and B:C ratio 2.41, 1.58 and 1.05 with fertilizer application rate of 120:60:60 kg NPK ha⁻¹, 75:45:45 kg NPK ha⁻¹ and 50:30:30 kg NPK ha⁻¹ respectively. The data showed that increasing the dose of fertilizer application resulted increase in the cost
of cultivation, gross returns, net returns and benefit: cost ratio. Similarly Thakur et al. (2000) reported that increased level of nitrogen application, cost of cultivation and average net returns increases significantly.

**EFFECT OF ZINC:** Zinc (Zn) has metabolically important role in plant growth and development and is therefore called an essential trace element or a micronutrient. It plays major role in synthesis of proteins, enzyme activation, oxidation and revival reactions and metabolism of carbohydrates. By utilizing of fertilizers contain zinc and other micronutrients, performance and quality of crops is gets enhanced and shortage of this elements due to decline in plant photosynthesis and destroys RNA, amount of soluble carbohydrates and synthesis of protein, resulting in decrease in performance and quality of crop (Mousavi et al., 2007; Efe and Yarpuz, 2011). Zinc has a key role as a structural constituent or regulatory co-factor of a wide range of enzymes and proteins in many important biochemical pathways and these are mainly concerned with carbohydrate metabolism, both in photosynthesis and in the conversion of sugars to starch, protein metabolism, auxin (growth regulator) metabolism, pollen formation, maintenance of integrity of biological membranes and resistance to infection by certain pathogens (Alloway, 2008). Zinc is an active element in biochemical processes and there is chemical and biological interaction between it and some other elements such as phosphorus, iron and nitrogen in plants. Phosphorus and copper have an antagonistic impact on zinc.

**Growth and growth component:** Sinha et al. (1995) reported the plant growth is affected due to deficiency of Zn induced by high P levels. Gozubenli et al. (2001) reported that stem diameters of pop corn was positively affected by zinc application. Chaab et al. (2011) from Tehran (Iran) reported that LAI (Leaf area index) and RGR (Relative growth rate) of maize increased with the application of zinc. Similarly Khan et al. 2008 and Zhoori et al. 2009 reported that zinc application improved the RGR and LAI. Mehdi et al. (2012) revealed that in fodder maize, zinc application at the rate of 10 kg ha\(^{-1}\) significantly increased plant height, leaf area index, N and Zn content and their uptake. Mehdi et al. (2012) revealed that zinc application at the rate of 10 kg ha\(^{-1}\) significantly increased green fodder yield of fodder maize.

**Yield and quality of fodder:** Singh and Singh (1998) reported the improvement in Zn content with increased levels of N, suggesting a synergistic effect of N on Zn uptake. Similarly Sharifi and Taghizadeh (2009) found that Zn application increased both N content and its uptake over control and it could be attributed to synergistic effect between N and Zn. Ashoka et al. (2008) reported that Zn application at 10 mg kg\(^{-1}\) soil caused significant increase in the Zn content and uptake by sorghum over application of 5 mg kg\(^{-1}\) soil and control. Similarly Chaab et al. (2011) from Tehran (Iran) reported that application of zinc significantly increased the shoot dry weight, zinc uptake and chlorophyll content in all cultivars of maize. Jaliya et al. (2008) reported a significant increase in the protein content and yield of maize with Zn application at 30 kg ZnSO\(_4\) ha\(^{-1}\)over 15 kg ZnSO\(_4\) ha\(^{-1}\). Farshid (2010) from Iran conducted experiment on maize crop and reported that Zinc application to the soil had no significant effect on leaf Zn content relative to the no Zn level but Zn spraying increased Zn concentration in the leaf from 32.8 to 45.2 mg kg ha\(^{-1}\), showing a 38% increase relative to the no Zn level. Aref (2012) from Iran reported that application of 16 kg Zn ha\(^{-1}\) significantly increased the P content in leaf of corn relative to control treatment. There was a synergism between Zn-P. The minimum mean leaf P concentration (0.34%) was obtained at no Zn level. Highest mean leaf P content (0.38%) was seen at 16 kg Zn ha\(^{-1}\). Keram et al. (2012) conducted experiment in Jabalpur, MP on wheat crop and observed that yield, harvest index, nutrient (N, K, Zn) uptake and quality increased significantly with the application of recommended dose of NPK and Zn @ 20 kg ha\(^{-1}\) by wheat as compared to NPK alone. The maximum yield (grain-4.66 and straw-5.44 kg ha\(^{-1}\)), harvest index (46.07), total nutrient uptake (N-123.19 kg ha\(^{-1}\), K-90.86 kg ha\(^{-1}\) and Zn-327.74 g ha\(^{-1}\)), total carbohydrate (70.37 per cent) and gluten (12.37 per cent) content was achieved by the application of 20 kg Zn ha\(^{-1}\) with recommended NPK as compare to control and other treatments, while total Puptake declined with increasing levels of Zn. Mehdi et al. (2012) reported that response of fodder maize to applied nitrogen up to 120 kg ha\(^{-1}\) was linear in nature. The treatment combination N\(_{120}\)Zn\(_{4}\)seed rate 60 kg ha\(^{-1}\) fetched higher net returns (Rs. 26,460 and benefit cost ratio 1.53).

**CONCLUSION**

It is concluded that judicious use of N, P & Zn improved the yield and quality of **kharif** fodder viz. maize, sorghum, bajra and teosinte. The optimized dose of these nutrients also depicted in enhancing the yield as well as advantageous to the growers.
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