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Economics of summer maize (*Zea mays* L.) as influenced by nano urea spray and hydrogel application

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Abstract

The field experiment was carried out during the summer season in two successive years of 2022 and 2023 at the Farm, Krishi Vidnyan Kendra, Gandheli, Chhatrapati Sambhajinagar, Maharashtra. The experiment was laid out in Split Plot Design along with two factors viz., three nano urea spray (60 Kg N Basal + 30 Kg N 30 DAS + 30 Kg N 45 DAS (Soil applied), 60 Kg N Basal + 30 Kg N 30 DAS (Soil applied) + (4 ml/L) spray of Nano Urea 45 DAS, 60 Kg N Basal + (4 ml/L) spray of Nano Urea 30 DAS + (4 ml/L) spray of Nano Urea 45 DAS) as main plot and (1.5 Kg soil applied Hydrogel, 2.5 Kg soil applied Hydrogel, 3.5 Kg soil applied Hydrogel, 4.5 Kg soil applied Hydrogel) as sub-plot factor treatment along with one control treatment and their combination of 15 treatments replicated thrice. Treatments were randomly arranged in each replication, divided into forty-five plots. Results revealed that the productivity and economics and energy studies of maize was influenced by nano urea spray and hydrogel application. On pooled analysis of both the year experiment, it was clearly evaluated that among application of 60 Kg N Basal + (4 ml/L) spray of Nano Urea 30 DAS + (4 ml/L) spray of Nano Urea 45 DAS produced higher economics viz., GMR, NMR, and B: C ratio and lower the cost of cultivation as compared the rest of treatments. Further in case of hydrogel application of 4.5 Kg soil applied Hydrogel (H5) produced higher growth and yield attributes. Therefore, the 60 Kg N Basal + (4 ml/L) spray of Nano Urea 30 DAS + (4 ml/L) spray of Nano Urea 45 DAS with foliar application of application of 4.5 Kg soil applied Hydrogel may be adopted by corn growers to harness the maize production and profitability under the ecological parameters of Maharashtra.

Keywords: Economics, hydrogel, nano urea spray, summer maize

Introduction

Maize (*Zea mays* L.) belongs to family *Poaceae* and it is world third important cereal crop after rice and wheat and is widely cultivated across the world (Sandhu *et al.*, 2007) ^[9]. The word “maize” is derived from the Spanish word. Globally, maize is known as queen of cereals because of its highest genetic yield potential. Maize is only food cereal crop that can be grown in different seasons and ecologies. Globally it is cultivated on nearly 150 m ha in about 160 countries having wider diversity of soil, climate, biodiversity and management practices that contributes 36 per cent (782 m t) in the global grain production. In Maharashtra, area and production of maize is about 1.15 m ha and 3.44 m tonnes respectively with productivity of 3000 kg/ha. The productivity of maize in Marathwada is low (1983 kg/ha) as compared to Maharashtra (Anonymous, 2022) ^[2]. There are many reasons for the low productivity of maize in Marathwada and Maharashtra viz., Hybrids and varietal selection, nutrient management, weed management, irrigation or water management etc. since maize is voracious feeder and exhaustive crop and required heavy nutrient doses specially of nitrogen, nutrient management is one of the most important for increasing the productivity of crop. Excessive application of N to crops in general leads to unwanted environmental consequences including accumulation of high nitrate and nitrite contents in leaf and fruiting bodies, among other problems such as eutrophication, environmental contamination in underground waters used for drinking. The use of nitrogen fertilizers results in higher biomass and protein yield and increases the concentration of protein in the plant tissue. As the protein concentration of corn grain increases, zein makes up

an increasing proportion of the protein (Sai *et al.*, 1992) [6]. Nitrogen fertilization also has problem of losses in soil application due to denitrification, volatilization, leaching, fixation and immobilization. To reduce the N losses and improve crop N uptake, it is suggested to increase the utilization efficiency of applied fertilizer.

Nano fertilizers are a novel concept in agricultural nutrient management, and while it is still in its early stages, there is a big push in agriculture for long-term crop development, with nano-nitrogen playing a significant role. Hydrogel (Super absorbent polymer) is a water retaining, cross-linked hydrophilic, biodegradable amorphous polymer which can absorb and retain water at least 400 times of its original weight and make at least 95 per cent of stored water available for crop absorption. When polymer is mixed with the soil, it forms an amorphous gelatinous mass on hydration and is capable of absorption and desorption over long period of time, hence acts as a slow-release source of water in soil. The hydrogel particles may be taken as “miniature water reservoir” in the soil and water will be removed from these reservoirs upon the root demand through osmotic pressure difference. The irrigation requirement of rabi maize is much more (6-7 irrigations) which increases cost of production. Its cultivation may be made more profitable by decreasing the demand of water and the frequency of irrigation.

Material and Methods

The experiment was laid out in field at farms, Mahatma Gandhi Mission, Krishi Vidnyan Kendra, Gandheli, Chhatrapati Sambhajanagar, Maharashtra during summer season of 2022 and 2023. The topography of experimental plot was fairly levelled. The soil was medium black in colour, high retentive of moisture, deep and fairly well drained. Geographically Krishi Vidnyan Kendra, Gandheli, Chhatrapati Sambhajanagar is situated at 19.92° north latitude north latitude and 75.35° east longitude and at 513 m altitudes above sea level and has a semi-arid climate. The mean maximum and minimum temperatures during the cropping period varied from 41 °C to 27 °C and 23 °C to 11 °C during 2022 and 41 °C to 26 °C and 23 °C to 11 °C during 2023 respectively. The mean relative humidity during morning and evening hours ranged between 61 to 83 and 64 to 39 percent and 62 to 87 and 64 to 39 percent during 2022 and 2023 respectively.

The experiment was laid out in Split plot design. The gross and net plot size were 4.5 m x 4.0 m and 4.0 m x 3.0 m, respectively. The experimental field was laid out after preparatory cultivation before sowing in Split plot design consisting 45 plots. The field was ploughed twice 15 days before sowing followed by harrowing. Well-decomposed farmyard manure at the rate of 12.5 t ha was applied uniformly over the field before last ploughing. Bold and healthy seeds were hand dibbled into the soil @ one seed per hill at a depth of 3-5 cm Bond NMH-007 is a hybrid maize variety. It is suitable for both *Kharif* and *Rabi* seasons and typically matures in 105-110 days. Harvesting of maize crop when husk has turned yellow and grains are hard enough having less than 30 percent moisture. Five plants from the net plot were randomly selected and used for recording observations on growth parameters periodically (25, 75 DAS and at harvest). In order to record the observation on various growth characters at different growth stages, 5 plants were selected randomly from each net plot. These selected plants were labelled for recording biometric observation and harvested separately for assessing per plant yield attributes. The experiment was laid out in split plot design. Gross return (INR/ha) is the total monetary value of the economic produce

(such as grains) and by-products (straw) obtained from the crop. It is calculated by multiplying the yield (of both main and by-product) with the prevailing market price and is expressed as INR/ha. The gross return from each treatment was calculated.

Gross return (INR/ha) = Income from the sale of maize grain and stover.

Net return (INR/ha) the net profit (Net return) from each treatment was calculated separately, by using the following formula.

Net return (INR/ha) = Gross return (INR/ha) - Cost of cultivation (INR/ha)

Benefit-cost ratio (B: C ratio) This index provides an estimate of the expenditure incurred in adopting a particular crop. It is calculated by the following formula.

$$\text{Benefit cost ratio} = \frac{\text{Gross return (INR/ha)}}{\text{Total cost of cultivation (INR/ha)}}$$

Subjected to statistical analysis by adopting the method of analysis of variance (ANOVA) as described by Gomez and Gomez (1984) [3]. The significance of comparison was tested. The significant difference values were computed for 5 percent probability of error. Wherever the variance ratio (F value) was found significant, critical difference (CD) values were computed for the comparison among the treatment means.

Results and Discussion

Effect of nano urea spray on economics summer maize

It is clearly perceptible from the data (Table 1) that nano urea spray gave significantly higher gross return (142343, 146857 and 144600 INR/ha during year 2022, 2023 and pooled analysis under application of 60 kg N Basal + 30 kg N 30 DAS (Soil applied) + (4 ml/L) spray of Nano Urea 45 DAS than other nano urea application. In other words, application of 60 kg N Basal + 30 kg N 30 DAS (Soil applied) + (4 ml/L) spray of Nano Urea 45 DAS was gave (16.38, 22.99 and 31.18 during 2022, 16.29, 22.25 and 32.53 during 2023, 16.33, 22.47 and 31.85 in pooled analysis) per cent more remunerative than 60 kg N Basal + 30 kg N 30 DAS (Soil applied) + (4 ml/L) spray of Nano Urea 45 DAS and application of 60 kg N Basal + 30 kg N 30 DAS + 30 kg N 45 DAS (Soil applied) respectively. The higher economics of the maize is due to the realization of maximum grain yield achieved by the adoption of comprehensive and integrated nitrogen management practices involving optimum level of basal nitrogen application and foliar nutrition of nano urea at peak reproductive stage of the crop. Similar kind of cost-effectiveness and economics was observed in maize by Ajithkumar *et al.* (2021) [1], in sweet corn by Rajesh *et al.* (2021) [4] and in green gram by Saiteja *et al.* (2022) [8] the application of basal nitrogen and foliar supplement of nano-nutrients.

Nano urea spray gave significantly higher net return (69,933, 74,442 and 72413 INR/ha during the year 2022, 2023 and pooled analysis under application of 60 kg N Basal + 30 kg N 30 DAS (Soil applied) + (4 ml/L) spray of Nano Urea 45 DAS than other treatments (Table 1). In other words, application of 60 kg N Basal + 30 kg N 30 DAS (Soil applied) + (4 ml/L) spray of Nano Urea 45 DAS treatment was given 30.12, 35.61 and 33.56% during 2022, 31.75, 36.65 and 34.65.52 during 2023 per

cent more remunerative with application of 60 kg N Basal + 30 kg N 30 DAS (Soil applied) + (4 ml/L) spray of Nano Urea 45 DAS and application 60 kg N Basal + 30 kg N 30 DAS + 30 kg N 45 DAS (Soil applied) respectively. Similar kind of cost-effectiveness and economics was observed Saiteja *et al.* (2022) [8].

In (Table 1) application of nano urea spray gave significantly more benefit/rupee invested (B: C ratio) i.e. 1.97, 2.03 and 2.00 during year 2022, 2023 and pooled analysis under application of 60 kg N Basal + 30 kg N 30 DAS (Soil applied) + (4 ml/L) spray of Nano Urea 45 DAS than other nano urea spray treatments. Nano urea, when used as a foliar spray, can lead to higher yields and, consequently, a better B: C ratio compared to traditional urea or no nitrogen application. Similar kind of cost-effectiveness and economics was observed by Saiteja *et al.* (2022) [8].

Effect of hydrogel on economics of summer maize

In Table 1 showing the hydrogel application had a significant influence on the gross return during both the years of investigation and also in pooled analysis. Application of 4.5 kg soil applied Hydrogel was recorded maximum gross return 1,29,510, 1,34,025 and 1,31,768 INR/ha during 2022, 2023 and pooled analysis, respectively. However, it was followed by application of 3.5 kg soil applied Hydrogel, application of 2.5 kg soil applied Hydrogel and application of 1.5 kg soil applied Hydrogel during both years and in pooled analysis. Hydrogel save much cost as compared to no application of hydrogel because the moisture availability increases the increases the yield and its direct result to economics in maize crop. In summer season. Similar finding was confirmed by Roy *et al.*, (2019) [5].

The hydrogel application had a significant influence on the net return during both the years of investigation and in pooled analysis. Application of 4.5 kg soil applied Hydrogel was recorded maximum net return 58,198, 63709 and 72478 INR/ha during 2022, 2023 and pooled analysis, respectively. However, it was followed by foliar application of 3.5 kg soil applied Hydrogel, 2.5 kg soil applied Hydrogel and 1.5 kg soil applied Hydrogel during both years and in pooled analysis. Similar

finding was confirmed by Roy *et al.*, (2019) [5].

The hydrogel application had a significant influence on the benefit: cost ratio during both the years of investigation and in pooled analysis. Hydrogel application of 4.5 kg soil applied Hydrogel was gave more benefit/rupee invested (B: C ratio) i.e. 1.86, 1.93 and 1.89 INR/ha during 2022, 2023 and pooled analysis, respectively. However, it was followed by application of 3.5 kg soil applied Hydrogel, application of 2.5 kg soil applied Hydrogel, application of 1.5 kg soil applied Hydrogel during both years and in pooled analysis. The application of hydrogel can positively influence the benefit-to-cost (B: C) ratio in maize cultivation, primarily by improving water retention in the soil and potentially boosting yields and direct impact on benefit to cost ratio. Hydrogel save much cost as compared to no application of hydrogel because the moisture availability increases the increases the yield and its direct result to economics in maize crop. Similar finding was confirmed by Roy *et al.* (2019) [5].

Conclusion

From the experimental finding it is therefore, being concluded that for more productive cultivation in term of economics among different spray of nano urea with application of 60 Kg N Basal + (4 ml/L) spray of Nano Urea 30 DAS + (4 ml/L) spray of Nano Urea 45 DAS is more beneficial among rest of the two nano urea spray as it gave 6.78 t/ha grain yield and 72,413 INR/ha. It can increase growth and yield vigorously due to their crop stage wise nitrogen supply potential which help to maximum return. The application of hydrogel with rate 4.5 Kg soil applied Hydrogel was more productive (6.20 t/ha) and economical (72,478 INR/ha) among rest of the hydrogel application as it supplies adequate moisture in most critical stages of summer maize and stimulate yield compare to other rate of application of hydrogel. Therefore, the different spray of nano urea with application of 60 Kg N Basal + (4 ml/L) spray of Nano Urea 30 DAS + (4 ml/L) spray of Nano Urea 45 DAS with application of 4.5 Kg soil applied Hydrogel may be adopted by summer maize growers to harness the maize production and profitability under the ecological parameters of Maharashtra.

Table 1: Economics of summer maize as influenced by nano urea spray and hydrogel application

Treatments	Economic returns											
	Cost of cultivation (INR/ha)			Gross returns (INR/ha)			Net returns (INR/ha)			B:C ratio		
	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
Nano urea spray												
N ₁	70490	70115	70802	119144	123658	121401	49067	53544	59590	1.60	1.76	1.68
N ₂	71009	71012	71011	123157	127671	125414	52148	56659	61580	1.74	1.80	1.77
N ₃	72410	72415	72413	142343	146857	144600	69933	74442	71773	1.97	2.03	2.00
S.Em (±)	4678	3987	2338	6312	62312	62312	4674	6526	2338	0.015	0.017	0.007
CD (P=0.05)	18368	10235	9183	24666	244666	244666	18354	25623	9183	0.057	0.051	0.029
Hydrogel Application												
H ₁	68276	68281	68278	127095	131609	129352	56819	61329	59550	1.60	1.83	1.71
H ₂	70379	70383	70381	127281	131795	129538	56902	62412	60642	1.77	1.84	1.81
H ₃	71376	71382	71379	128512	133026	130769	56135	62644	60258	1.80	1.86	1.83
H ₄	72476	72480	72478	128674	133189	130931	57198	63709	60339	1.81	1.87	1.84
H ₅	74674	73377	73526	129510	134025	131768	58192	64648	63784	1.86	1.93	1.89
S.Em (±)	7796	6987	3898	109471	109471	109471	7796	11127	3898	0.024	0.012	0.012
CD (P=0.05)	22756	18369	11378	319522	319522	319522	22756	32477	11378	0.071	0.036	0.036
Nano Urea x Hydrogel (N x H)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

N₁: 60 kg N Basal + 30 kg N 30 DAS + 30 kg N 45 DAS (Soil applied), N₂: 60 kg N Basal + 30 kg N 30 DAS (Soil applied) + (4 ml/L) spray of Nano Urea 45 DAS, N₃: 60 kg N Basal + (4 ml/L) spray of Nano Urea 30 DAS + (4 ml/L) spray of Nano Urea 45 DAS, H₁: Control, H₂: 1.5 kg soil applied Hydrogel, H₃: 2.5 kg soil applied Hydrogel, H₄: 3.5 kg soil applied Hydrogel, H₅: 4.5 kg soil applied Hydrogel

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