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Effects of different levels of NPK Fertilizers and delayed sowing on seed germination, electrical conductivity and protein content of Maize (*Zea mays* L.) Varieties

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Abstract
The present study was conducted in Post Graduate laboratory of Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology & Sciences, Allahabad (U.P) during Kharif 2017 to investigate the effectiveness various levels of NPK fertilizers, their combinations (T_1) 26g Urea: 42g DAP :20g MOP / 2 m^2 (T_2), 52g Urea: 84g DAP :40 g MOP/ 2 m^2 (T_3), 78g Urea: 126 g DAP :60g MOP / 2 m^2 and delayed sowing on quality characters of three varieties of maize. The three varieties (Kaveri 3110 (V_1), Deluxe (V_2), Ganga-2 (V_3). each were treated with different levels of fertilizers (Urea - 26 g,52g and 78 g) which supplies nitrogen, (DAP- 42g,84g,124g) which supplies nitrogen and phosphorous, (MOP- 20g,40g,60g) which supplies potassium. The seeds which are harvested were used in the experiment. The experimental design was Completely Randomized Design(CRD) with four replications. The results showed that germination, shoot length, vigor index II shows higher in treatment combination T_1 and V_3 (ganga), germination energy is high in both combinations V_2T_2, V_3T_1, Speed of germination, seedling length, fresh weight, dry weight is higher in V_2 and treatment 2(Deluxe) and electrical conductivity is lowest in V_2T_2 which it means leaking of leachates is less in this treatment (high vigour). Where as in protein estimation is done by Lowry's method which it shows high amount of protein in the treatment combination V_2T_2.

Keywords: Maize, Seed quality, NPK fertilizers

Introduction
Maize (*Zea mays* L.) is the third most important cereal crop native to Mexico. Maize or corn is a plant belonging to the family of grasses (Poaceae) having chromosome number 2n =20. It is one of the most versatile emerging crop having wider adaptability under varied agro-climatic conditions. Globally maize is known as "Queen of Cereals". In India, it is cultivated in 9.43 M ha and Production and productivity is 23.67 MT and 2557 kg/ha respectively (DESMOA on maize, 2015) [5].

One of the reasons maize is a staple food across the world is its high nutritional value, with high levels of starch and also valuable proteins and oils.

Maize is a good source of dietary fiber and protein, while being very low in fat and sodium (salt). However, maize is naturally deficient in lysine and tryptophan. Maize has tremendous variation in content and composition of several colored of several colored pigments collectively known as carotenoids.

Notably, the carotenoid beta-carotene (or provitamin A) is converted to vitamin A by normal metabolic processes in the body. Vitamin A is very important to human health, but most especially for vision, and as an antioxidant.

Maize has different quality standards depending on the use of the crop. Maize grown for animal feed would need to have high protein and starch content, and for human consumption it should have low moisture level as well as high grain weight. Maize has different quality standards depending on the use of the crop.

Good crop nutrition will ensure high protein and energy levels of grain in the maize cob

Fertilization is a widely used practice to correct nutritional deficiencies in plants caused by improper supply of nutrients to roots.

Maize requires application of nutrient such as:

Nitrogen which is the most important nutrient and role player in the growth, yield and quality of maize crops. Nitrogen deficiency thus results in poorer quality grains and a decrease in total yield.

Low and high nitrogen dose have adverse effect on quality of maize (Stone *et al.*, 1998) [19].

Phosphorus which is essential for root development and growth of the maize plant, as it directly affects the growth tips of the plant. The P concentration in corn hybrids depends on its genetics and environments where it is grown (Gautam *et al.,* 2011) [8].

Potassium also help minimizing the effects of frost damage and reduces lodging. Potassium is most important for stomatal closure and low supplies result in loss of water from the plant.

Potassium fulfils a number of roles in maize plants including regulating the water content (beneficial in periods of drought), the transportation of sugar from the leaves and maintaining the plant rigidity.

High seed quality is necessary to establish crops, therefore cultivated seed should have vigour and related physiological characters Maximum seed vigour is attained at harvest maturity and not at physiological maturity (Wambagu *et al.*, 2012) [20]. Fertilizer applications led to a significant increase in seed vigour and viability the higher oil content of pollinator seed may influence seed germination and vigour. Maize grown without fertilizer N promotes the greatest concentration of kernel starch, which has on average greater than kernels grown with the maximum N supply (Seebauer *et al.,* 2010). Nitrogen fertilizer application reduces phosphorus content of maize and increases crude protein content significantly (Khogali *et al.*, 2011) [12].

Protein quality is a relevant factor for producers and consumers, especially when grain quality determines the final price of the commodity (Da Silva *et al.,* 2005) [6]. Quality characteristics in maize such as protein contents in seed is improved with optimum N level. Application of various N levels significantly influences seed protein content (Hammad *et al.,* 2011) [9]. Without application of nitrogen, seed quality will extremely be decreased. Nitrogen application at silking increases kernel crude protein content, up to the application of 100 kg ha-1 nitrogen (Da Silva *et al.,* 2005) [6]. This response showed that N applied during flowering is taken by the plant and accumulated in the grains. The advantage of increasing grain protein content with late N-side dressing is reducing kernel susceptibility to breakage at harvesting, a feature that allows greater aggregation of commercial value to the product. There is significant negative relationship between starch content and crude protein (Idikut *et al.,* 2009) [10]. The crude protein decreases with increasing starch content of maize grain.

According to Lee and Tollenaar (2007) [13] The grain quality of late season maize is better than the early season maize and the grain can be better stored and preserved. There is less attack of insect pest and disease organisms during late season. Therefore, late season is more suited for both seed and grain production than the early season.

Materials and Methods

The present study was conducted in Post Graduate laboratory of Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology & Sciences, Allahabad (U.P) during Kharif 2017- 2018.

The test was in factorial Completely Randomized Block Design. Three levels of fertilizers were applied to the plot.

Instrument used

Conical flask, Measuring scale, Micro centrifuge
Tubes, Pipette, Micropipettes, Beakers,
Volumetric flasks, Test Tubes, Petri plate.

Equipment used

Weighing Machine, Centrifuge Machine.

Chemicals used

Double Distilled water**,** 2 % Na2Co3, 0.1 N NaOH**,**
0.5 % CuSo4.5H2O, 0.5 % Sodium potassium tartrate
Folin-Ciocalteu Reagent (FCR), Bovine serum albumin (BSA)

The various parameters recorded during developmental and growth at distinct phases of crop were Plant height, Tassel length, Leaf length, Leaf width, Cob length, Cob diameter, No of cobs per plant, No of rows per cob, No of grains per row, No of seeds per cob, 100 seed weight, seed weight per plot.

A) Varieties
V1 (Kaveri-3110)
V2 (Deluxe)
V3 (Ganga – 2)

B) Fertilizers (Treatments)
T_0 - Control
T_1 - 26g Urea: 42g DAP :20g MOP / 2 m^2
T_2 - 52g Urea: 84g DAP :40 g MOP/ 2 m^2
T_3 - 78g Urea: 126 g DAP :60g MOP / 2 m^2

Statistical Analysis

The data recorded was analyzed using formula of Completely Randomized Design (CRD). Comparisons of means were done by utilizing Least Significance Difference (LSD) test at 5 % level.

Results and Discussions

All the 12 quality characters which are analyzed through CRD showed that the treatment combinations

Effect on seed germination

Germination percent (%)

Data appended in Table 2 indicated that different levels of NPK have influenced germination percentage of seeds of maize significantly Among different levels of NPK fertilizers, maximum germination percent (97 %), was noticed in interaction V_2T_1 followed by (96 %) V_1T_1 (Table 2) and minimum was recorded from control (V_1) is 89 %.

The germination percentage was reported to be maximum with the high levels of NPK. Attributed to the fact that there are increased seed protein contents, seed protein yield, seed weight and seed size as compared to lower application of nitrogen. The improved protein contents in seed is known to increase the germination percentage.

Similar findings Ali *et al* (2007), Ramteke. An et *al* (2012) [17] reported that highest seed germination was observed with the application of combined doses of nitrogen and potassium at higher levels in comparison to lower levels.

Germination Energy

Data appended in Table 2 indicated that different levels of NPK have influenced germination energy of seeds of maize significantly Among different levels of NPK fertilizers, maximum germination energy maximum germination energy (71 %), was noticed in interaction V_2T_2 and V_3T_1 followed by (69.5 %) in V_1T_3 and minimum was recorded from control (V_1) is 46.50 %.

The germination energy was reported to be maximum with

the high levels of NPK. The increase in germination energy with the application of higher doses of nitrogen can be attributed to the fact that the faster initiation of metabolic activities in the seed. Similar findings were also reported by Azimi *et al* (2013), Ashagre *et al* (2013).

Speed of germination

Data appended in Table 4.3 (c) indicated that different levels of NPK have influenced speed of germination seeds of maize significantly Among different levels of NPK fertilizers, maximum dry weight (67.71), was noticed in interaction V_2T_2, followed by (64.87) V_1T_1 (Table 4.3 c) and minimum was recorded from control (V_1) is 48.22.

The speed of germination was reported to be maximum with the high levels of NPK. The increase in speed of germination with the application of higher doses of nitrogen can be attributed to the fact that the faster initiation of metabolic activities in the seed. Similar findings were also reported by Azimi *et al* (2013), Ashagre *et al* (2013).

Root length

Perusal of data appended in Table 2 indicated that different levels of NPK as well as their interaction effects have influenced root length of maize significantly Among different levels of NPK, maximum root length (17.59 cm), was noticed in interaction V_2T_2, followed by (17.45cm) V_2T_3 (Table 4.3 d) and minimum was recorded from control (V_1) is 14.05 cm.

Higher levels of NPK and their combined doses have increased the root length significantly. The reason could be that the nutrients applied at optimum rate induced the formation of proteins, carbohydrates as well as enzymes in adequate quantity which would have acted on the metabolites in the seed and resulted in the better seed quality and produced taller roots. The results got support from earlier finding of Narayanan (2006) [16], who reported that higher levels of NPK and their combined doses have increased the root length. Similar findings were recorded by Ramteke *et al* (2012) [17].

Shoot length

Perusal of data appended in Table 2 indicated that different levels NPK as well as their interaction effects have influenced shoot length of maize significantly Among different levels of NPK, maximum shoot length (14.73 cm), was noticed in interaction V_2T_2, followed by (14.63cm) V_2T_1 (Table 4.3 e) and minimum was recorded from control (V_1) is 11.48 cm.

Higher levels of NPK and their combined doses have increased the shoot length significantly. The reason could be that the nutrients applied at optimum rate induced the formation of proteins, carbohydrates as well as enzymes in adequate quantity which would have acted on the metabolites in the seed and resulted in the better seed quality and produced taller shoots. The results got support from earlier finding of Narayanan (2006) [16] who reported that higher levels of NPK and their combined doses have increased the shoot length. Similar findings were recorded by Ramteke *et al* (2012) [17].

Seedling length

Perusal of data appended in Table 2 indicated that different levels of NPK as well as their interaction effects have influenced shoot length and root length of maize significantly Among different levels of NPK, maximum seedling length (32.08 cm), was noticed in interaction V_2T_2, followed by (31.76 cm) V_3T_2 (Table 2) and minimum was recorded from control (V_1) is 25.54 cm.

Higher levels of NPK and their combined doses have increased the shoot length and root length significantly. The reason could be that the nutrients applied at optimum rate induced the formation of proteins, carbohydrates as well as enzymes in adequate quantity which would have acted on the metabolites in the seed and resulted in the better seed quality and produced taller seedlings. The results got support from earlier finding of Narayanan (2006) [16] who reported that higher levels of NPK and their combined doses have increased the shoot length and root length. Similar findings were recorded by Ramteke *et al* (2012) [17].

Fresh weight

A perusal of data presented in Table 2 indicated that different levels of NPK as well as their interaction effects have influenced seedling fresh weight significantly Maximum fresh weight (7.16 g), was noticed in interaction V_2T_2, followed by (6.90 g) V_1T_1 (Table 2) and minimum was recorded from control (V_3) is 5.36 g.

The application of combined doses of NPK levels especially at higher doses have increased the seedling fresh weight as compared to lower doses due to the fact that nutrients applied at optimum rate induced the formation of protein and enzymes as well in adequate quantity which might have acted on the metabolites in the seed and resulted in the better seed quality and hence more seedling fresh weight. Similar finding has been documented by Narayanan (2006) [16]. Similar findings were recorded by Ramteke *et al* (2012) [17].

Dry weight

A perusal of data presented in Table 2 indicated that different levels of NPK as well as their interaction effects have influenced seedling dry weight significantly Maximum dry weight (3.65 g), was noticed in interaction V_2T_2, followed by (3.64 g) V_2T_1 (Table 2) and minimum was recorded from control (V_1) is 2.79g.

The application of combined doses of NPK levels especially at higher doses have increased the seedling dry weight as compared to lower doses due to the fact that nutrients applied at optimum rate induced the formation of protein and enzymes as well in adequate quantity which might have acted on the metabolites in the seed and resulted in the better seed quality and hence more seedling dry weight. Similar finding has been documented by Narayanan (2006) [16] Similar findings were recorded by Ramteke *et al* (2012) [17].

Vigour index I

Data presented in Table 2 indicated that different levels of NPK and their interaction have significantly influenced seed vigour index-I of maize. Among different levels of NPK, maximum seed vigour index I (3135), was noticed in interaction V_2T_2, followed by (2476.64) V_3T_2 (Table 2) and minimum was recorded from control (V_1) is 2126.62.

Higher levels of NPK and their combined applications had increased the seed vigour index I significantly as compared to lower doses due to proper development of seed. Similar finding has been documented by Narayanan (2006) [16]. Similar findings were recorded by Ramteke *et al* (2012) [17].

Vigour index II

Data presented in Table 4.2 indicated that different levels of NPK and their interaction have significantly influenced seed

vigour index-II of maize. Among different levels of NPK, maximum vigour index II (353), was noticed in interaction V_2T_2, followed by (346.38) V_2T_1 (Table 2) and minimum was recorded from control (V_1) is 247.85g

Higher levels of NPK and their combined applications had increased the seed vigour index II significantly as compared to lower doses due to proper development of seed. Similar finding has been

Table 1: ANOVA for seed quality characters in Maize varieties

S. No.	Characters	Mean squares	
		Treatments (df= 11)	Error (df=36)
1.	Germination%	25.46**	6.89
2.	Germination Energy	262.45**	24.08
3.	Speed of germination	128.36**	7.50
4.	Shoot length	5.86**	0.58
5.	Root length	6.67**	0.36
6.	Seedling length	20.12**	1.16
7.	Fresh weight	1.29**	0.07
8.	Dry weight	0.41*	0.02
9.	Vigour index-I	323168**	18.49
10.	Vigour index-II	5544.32**	2206.03
11.	Electric conductivity	0.008*	2.32

**** Significant at 5 % and 1% level of significance, respectively

Table 2: Effect of interaction b/w varieties and treatments on seed quality characters of Maize during *Kharif* – 2017-18

S. No	Characters\ Treatments		Germination %	Germination Energy	Speed of germination	Root length	Shoot length	seedling length	fresh weight	dry weight	vigour index-I	vigour index-II	EC
1	V1T0		89.00	46.50	48.22	14.06	11.48	25.54	6.11	2.79	2274.46	247.85	0.462
2	V1T1		96.00	65.00	64.87	15.69	13.39	29.07	6.90	3.48	2712.69	332.73	0.442
3	V1T2		94.00	64.00	53.31	16.10	14.17	30.20	6.19	3.35	2500.95	314.49	0.405
4	V1T3		92.50	69.50	55.71	16.85	12.91	29.75	5.91	2.96	2753.31	274.21	0.442
5	V2T0		90.00	53.00	50.13	14.08	12.08	26.15	5.58	2.93	2126.62	271.93	0.452
6	V2T1		97.00	69.00	52.57	16.00	14.73	30.72	6.81	3.64	2958.04	352.99	0.442
7	V2T2		95.00	71.00	67.71	17.45	14.63	32.08	7.16	3.65	2904.11	346.38	0.402
8	V2T3		93.00	68.50	55.65	17.59	12.58	30.11	6.02	2.96	2806.85	340.66	0.412
9	V3T0		89.50	55.50	51.04	14.15	11.50	25.65	5.36	2.89	2297.60	258.32	0.462
10	V3T1		93.00	71.00	55.87	15.62	14.41	30.02	6.48	3.48	2794.61	323.22	0.412
11	V3T2		94.50	70.00	56.05	17.37	14.43	31.76	6.64	3.15	2976.64	298.65	0.422
12	V3T3		92.50	67.50	54.89	16.24	12.74	28.98	5.67	2.91	2683.03	268.73	0.422
13	Mean		93.00	64.21	55.50	15.93	13.25	29.17	6.23	3.18	2649.07	302.51	0.431
14	Range	Min	89.00	46.50	48.22	14.06	11.48	25.54	5.36	2.79	2126.62	247.85	0.402
		Max	97.00	71.00	67.71	17.59	14.73	32.08	7.16	3.65	2976.64	352.99	0.462
15	SE.(d)		6.43	12.02	9.49	1.46	1.87	2.64	0.65	0.35	10.53	115.05	3.73
16	C.D.5%		3.77	7.03	0.01	0.85	1.11	1.55	0.41	0.21	6.16	67.35	0.00
17	C.V.		2.82	7.64	0.02	3.73	5.80	3.69	4.49	4.47	0.16	15.52	0.36

documented by Narayanan (2006) [16]. Similar findings were recorded by Ramteke *et al* (2012) [17].

NPK and their combined applications at higher doses have increased the seed vigour index-II significantly as compared to lower doses due to the fact that nutrients applied at higher rate might have induced the formation of proteins and enzymes in adequate quantity which would have acted on the metabolites in the seeds and resulted in the better seed development and quality and hence more seed vigour index-II.

Electrical conductivity on seed leachates

A cursory glance of data in Table 2 indicated that different levels of NPK as well as their interaction have exhibited significant effects on electrical conductivity of seeds of maize Minimum electric conductivity (0.402), was noticed in interaction $V_2T_{2,\ which}$ it means seeds of these treatment has high vigour, followed by (0.405) V_1T_2 2 and maximum was recorded from control V_1T_0 and V_1T_0 is 0.462.

Electrical conductivity of seeds was reported maximum in control as a consequence of the facts that the seeds might have leaked more solutes when placed in water and hence less vigorous seeds. Whereas, minimum electrical conductivity was reported with the highest dose of NPK which could be due to the fact that the seeds were highly vigorous.

Estimation of total Protein by Lowry's method

The nine seed samples of all three maize varieties (*Zea mays)* of farmers variety and then estimation of total protein was done by Lowry's method

Application of different levels of NPK on maize protein content was found effective over the control in all the treatments. Among three levels of NPK treatments, Treatment (T_1) and variety V_2(Deluxe) superior and significantly gave maximum values (Fig. 4.26).

This beneficial effect is due to nitrogen and it plays very important role in plants and seeds. The enhancing effect of nitrogen on maize seed protein content might be attributed to the direct role of N in protein formation and also its favorable effect on the accumulation of NPK nutrients coupled with their cumulative effect on metabolism related protein synthesis in maize seeds and Nitrogen also influence on the ribosome structure and the biosynthesis of some hormones (gibberellins, auxins and cytokinin's) involved in protein synthesis. Similar findings were recorded by, Minu Singh (2014).

Table 3: Spectrophotometric readings of the Working Standard Protein (BSA) solution.

Standard	Volume (ml)	Absorbance (O.D) at 660 nm
BSA	0 (blank)	00
	0.2	0.138
	0.4	0.232
	0.6	0.322
	0.8	0.481
	1.0	0.620

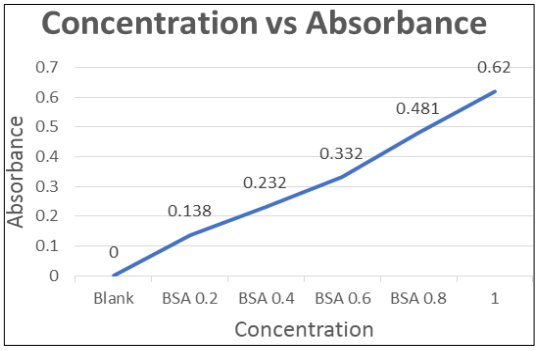

Fig.4.24: Standard curve of BSA.

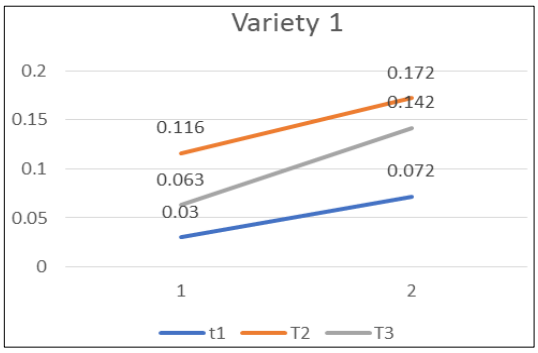

Fig 4.25: Estimation of protein of different treatments of V_1

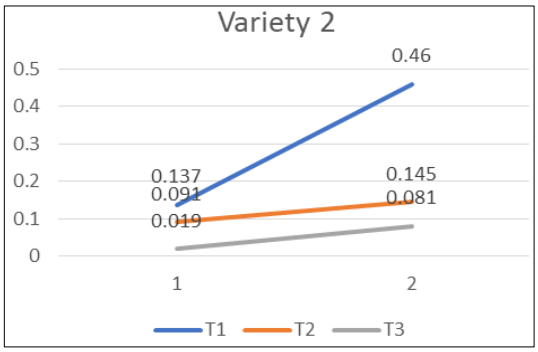

Fig 4.26: Estimation of protein of different treatments of V_2

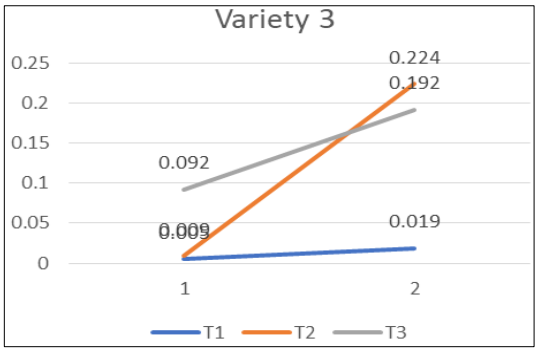

Fig 4.27: Estimation of protein of different treatments of V_3

Conclusion

The results showed that germination, shoot length, vigor index II shows higher in treatment combination T_1 and V_3 (ganga), germination energy is high in both combinations V_2T_2, V_3T_1, Speed of germination, seedling length, fresh weight, dry weight is higher in V_2 and treatment 2(Deluxe) and electrical conductivity is lowest in V_2T_2 which it means leaking of leachates is less in this treatment (high vigour). Where as in protein estimation is done by Lowry's method which it shows high amount of protein in the treatment combination V_2T_2.

However, fertilizer and their combinations with varieties was found to be beneficial

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