Original Research Article

Effect of Seed Priming and Fertilizer Levels on Growth, Yield Attributes and Yield of *Rabi* Maize.

ABSTRACT

The present investigation was conducted during the *rabi* season of 2019-20 at B block of college Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari to study the "Effect of seed priming and fertilizer levels on *rabi* maize under south Gujarat condition". The experiment was laid out in Randomized Block Design with factorial concept (FRBD) with ten treatment combinations consisting of two factors the first factor was seed priming, Control (No priming), Seed priming with water for 12 hrs., Seed priming with 0.5% KCl for 12 hrs., Seed priming with 0.5% $KMnO_4$ for 12 hrs., Seed priming with 0.5% KH_2PO_4 for 12 hrs. The second factor was fertilizer levels, 75% RDF (112.5+45+00, N: P_2O_5: K_2O kg/ha) and 100 RDF (150+60+00, N: P_2O_5: K_2O kg/ha). Treatments are replicated three times. The experimental result indicates that treatment of Seed priming with 0.5% KH_2PO_4 for 12 hrs recorded significantly higher plant population, number of leaves per plant, plant height, grain and straw yield compared to other treatments. In case of fertilizer levels number of leaves per plant and plant height recorded non significant at 30 DAS. Significantly higher plant height at 60 DAS, 90 DAS, at harvest, grain and straw yield recorded in treatment of 100% RDF (150+60+00, N: P_2O_5: K_2O kg/ha). Treatment combination S5F2: (KH_2PO_4 at 0.5 % for 12 hrs with 100% RDF i.e., 150+60+00, N: P_2O_5: K_2O kg/ha) recorded significantly higher plant height at 90 DAS, at harvest, Grain and straw yield as compared to other treatments. Thus a combination of Seed priming with 0.5% KH_2PO_4 for 12 hrs with 100% RDF (150+60+00, N: P_2O_5: K_2O kg/ha) helps in enhancing the growth parameters, yield attributes and yield of rabi maize without negative influence on plant and the environment.

Keyword: Seed priming, fertilizer, yield and maize

1. INTRODUCTION

Maize (*Zea mays* L.) is an important cereal crop in world after wheat and rice. The importance of maize lies in its wide industrial applications besides serving as human food and animal feed. It is the most versatile crop with wider adaptability in varied agro-ecologies and has highest yield potential among the food grain crops. As the demand for maize is growing globally due to its multiple uses for food, feed and industrial sectors, we need to produce more from same or even less resources.

Maize is predominately a kharif season crop but in past few years rabi maize has gained a significant place in total maize production in India. In Gujrat state maize is grown in 2.82 lakh ha in kharif and 1.11 lakh ha in winter rabi with production of 8.26 lakh tones and productivity 2098 kg/ha during the year 2023-24 (indiastat.com). In India rabi maize is grown on an area of 1.75 million ha with the grain production of 9.75 million tonnes, with an average productivity rate of 5555 kg/ha during 2023-24 (indiastat.com). In world area and production of maize is about 197.18 million ha and 1134.70 million tonnes, respectively with productivity of about 5755 kg/ha during the year 2017-18 (Anon., 2020).

Germination and seedling emergence are the critical stages in the plant life cycle. Insufficient seedling emergence and inappropriate stand establishment are the main constraints in the production of crops which receiving less rainfall. Among the various agronomic factor, seed priming is important factor for enhancing yield of rabi maize. Seed priming is a useful treatment, applied prior to planting. Seed can be primed by either uncontrolled hydration- hydro priming (Casenave and Tosselli, 2007) or osmo-priming involves the use of adverse osmotic solutions, like different salts such as KCl, KNO_3 and KH_2PO_4 etc.

There are several factors that affect the productivity of rabi maize however, the fertilizer management is one of the most important factors that affect the growth and yield of maize. Maize is an exhaustive crop which requires all types of macro and micro nutrients in order to get better growth and exploit yield potential.

2. MATERIALS AND METHODS

2.1 Description of experiment site

The field experiment was conducted at B-block of Agronomy Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari during rabi season of 2019-20. Navsari Agriculture University campus is geographically located at 200 57’ N latitude and 720 54’ E longitudes at an altitude of 10 meters above the mean sea level. The climate of this region is characterized by fairly hot summer, moderately cold winter and warm humid monsoon with heavy rainfall. The winter season sets usually in the first week of November and continues up to the middle of February. The soil of the experimental plot was alkaline in reaction, colour of dry soil is dark brown and textured clay.

2.2 Treatments and Experimental Design

Total ten treatment combinations of two factors will be evaluated as under Factor I- Seed priming (S) S1: Control (No priming), S2: Seed priming with water for 12 hrs, S3: Seed priming with 0.5% KCl for 12 hrs, S4: Seed priming with 0.5% $KMnO_4$ for 12 hrs and S5: Seed priming with 0.5% KH_2PO_4 for 12 hrs. Factor II- Fertilizer levels (F) F1: 75% RDF (112.5+45+00 N: P_2O_5: K_2O kg/ha) F2: 100% RDF (150+60+00 N: P_2O_5: K_2O kg/ha). Common application of Bio compost 5 t/ha in every treatment combination. The experiment followed a Randomized Block Design (Factorial concept) with three replications, featuring plots of 6.0 m ×5.0 m each.

2.3 Experimental procedures and field management

Three chemicals (KCl, $KMnO_4$ and KH_2PO_4) used for seed priming. The solution of these chemicals prepares by dissolving 5g (of each chemical) per liter of distilled water separately to make 0.5% solution beside this treatment only water treatment also given with same quantity of water. Seed of rabi maize were soaked in prepared solution of all the chemicals separately for 12 hrs. after soaking the seed were dried in shade until seed coat become dry (Sharma and Parmar 2018). Total quantity of phosphorus and half quantity of nitrogen were applied as basal dose and remaining half dose of nitrogen given as a split application after three weeks of sowing. The nutrients were applied in the form of urea (46% N) and single super phosphate (16% P_2O_5) with dose 150+60+00 N: P_2O_5: K_2O kg/ha by the method of band placement with different dose according to treatment

The field was prepared with the help of a tractor drawn M.B. plough and planking and experiment was laid out as per the layout plan. Recommended seed rate of 20 kg/ha was used for sowing. Plot wise quantity of seed was weighted and applied different priming techniques as per treatment before sowing and sown manually at the depth of 4-5 cm by line sowing. Irrigations were given five times. First irrigation was given just after sowing for proper germination. For effective weed control, one hand weeding was carried out at 30 DAS with inter cultivation with mechanical weeder. In general, the crop stand was satisfactory and there was no ever incidence of pest and disease attack, so general application of Carbofuran 3G @15 kg/ha at 20 DAS was taken against maize stem borer.

2.4 Data Collected and collecting Procedure

The initial and at harvest plant population count was recorded by counting total number of plants emerged in net plot. The plant population was recorded at 20 days after sowing and at harvest converted on hectare basis. For recording number of leaves per plant, all the green and developed leaves from randomly selected and tagged five plants were counted at 30, 60, 90 DAS and at harvest. The height of five earlier randomly selected and tagged plants was measured from the base of plant to the tip of main shoot at 30, 60, 90 DAS and at harvest of the crop. The mean plant height was calculated and expressed in cm. The days required from sowing to attain 50 per cent flowering were recorded for each treatment separately by considering 50% flowered plants from net plot. The five cobs from the five tagged plants were used for measure a cob length. Length of the five cobs were measured in cm from the bottom end to the tip of the cob and mean values were recorded a cob length. The same five cobs which were used for cob length measurement were also used for measuring the girth. The girth was measured in cm from the top, middle and bottom of the cobs. Cobs from all the plants of each net plot were harvested separately and allowed to sun drying for about ten days. After complete drying of cobs, the grains were separated from the cobs with the help of wooden sticks. The produce obtained in this way was cleaned and weighed. The total grain weight per plot after adding the grain weight of five sample plants was recorded and finally converted in hectare basis. After harvesting the cobs from the plants, the plants were harvested from the net plot separately and allowed to sun drying for about ten days in the field. Then it was tied into bundles of suitable size and straw yield per net plot was recorded. The total straw yield per net plot was recorded after addition of straw weight of five sample plants and finally converted into hectare basis.

3 RESULT AND DISSCUTION

3.1 Plant population

Significantly higher plant population (table 1) was recorded at 20 DAS and at harvest with the treatment of S5 which was remained at par with treatment S3 whereas, significantly lowest plant population was recorded at 20 DAS and at harvest with control treatment (No priming). Higher plant population might be due to the fact that KH_2PO_4 have been introduced as the osmotica which have shown good potential to enhance emergence, germination and better stand establishment. KH_2PO_4 showed a relatively positive effect apparently because phosphorous reserves in the seed play very important role in the metabolism of germinating seed. These results are in accordance with the findings of Toklu *et al.* (2015). plant population recorded at 20 DAS and at harvest were found non-significant with fertilizer levels. However, numerically higher plant population at 20 DAS and at harvest was recorded with application of treatment F2 than treatment F1.

3.2 No. of leaves per plant

A data given in Table 1 revealed that No. of leaves per plant recorded at 30 DAS, 60 DAS, 90 DAS and at harvest were significantly influenced by different seed priming treatments. Significantly higher No. of leaves per plant was recorded at 30 DAS, 60 DAS, 90 DAS and at harvest with the treatment of S5 which was remained at par with S3. The significantly higher No. of leaves per plant might be due to rapid and uniform emergence and higher vigour of seedlings Banerjee *et al.* (2020). No. of leaves per plant recorded at 30 DAS were found non-significant with fertilizer levels and at 60 DAS, 90 DAS and at harvest were significantly influenced by different fertilizer levels. Significantly the highest No. of leaves per plant was recorded with application of treatment F2 at 60 DAS, 90 DAS and at harvest as compared to treatment F1. The increase no. of leaves per plant might due to higher availability of Nitrogen and Phosphorus Thorat *et al.* (2016).

3.3 Plant Height (cm)

A data given in (Table 1) revealed that plant height (cm) recorded at 30 DAS, 60 DAS, 90 DAS and at harvest were significantly influenced by different seed priming treatments. Significantly higher Plant height (cm) was recorded at 30 DAS, 60 DAS, 90 DAS and at harvest with the treatment of S5 which was remained at par with treatment S3 and plant height also at 30 DAS at par with treatment S4. Bhowmick *et al.* (2014) reported that KH_2PO_4 solution and priming can improve germination, reduce lipid peroxidation, enhance anti-oxidative activity and improve seedlings growth. Increase in plant height has been due to increasing plasticity of the cell wall followed by hydrolysis of starch to sugars which lowers the water potential of cell, resulting in the entry of water into the cell causing elongation. These osmotic driven responses under the influence of gibberellins might have been attributed to increase in photosynthetic activity, enhanced translocation and efficiency of utilizing the photosynthetic products, thus subsequent in increased cell elongation and rapid cell division in the growing part. Chiu *et al.* (2002) also found the increases in plant height due to proper crop establishment that enhanced nutrient uptake which encourage and improve plant growth and promote cell division. These results accordance with the findings of Banerjee *et al.* (2020) and Miraj *et al*. (2013). Significantly higher plant height was recorded with application of treatment F2 at 60 DAS, 90 DAS and at harvest as compared to treatment F1. During initial stage the increase in plant height due to levels of N did not caused significant variation. Later on, increased plant height might be due to increasing level of nitrogen as it increases cell division, cell elongation and nucleus formation. Probably the increase in auxin supply with higher levels of nitrogen brought about increase in the dry matter and enhances the plant growth. Pal *et al.* (2017) observed P fertilization improves the various metabolic and physiological processes and which subsequently used for vegetative and reproductive growth through photo phosphorylation. These results are in conformity with the findings of Dharaiya *et al.* (2018) and Pal *et al* (2017).

3.4 Days To 50% Flowering

A data presented in Table 2 revealed that days to 50% flowering were found non-significant with seed priming and fertilizer levels. However, numerically the lower days to 50 percent flowering (57.5 days) were observed under the treatment S5 and F2. Effect of seed priming and fertilizer levels did not exert their significant effect on days to 50% flowering which indicates its dominance genetical inheritance characteristic of the variety.

3.5 Cob Length cm) and Cob Girth (cm)

A data given in Table 2 revealed that cob length (cm) was significantly higher with the treatment of S5 which was not found to be statistically at par with any treatment. Similar results were also observed by Priya *et al.* (2011). cob length (cm) and cob girth (cm) (table 2) was significantly higher with application of treatment F2. N level increased, the rate of vegetative and reproductive growth increased in plant due to increase in assimilating surface of plant as well as total photosynthesis, maize is largely governed by source (photosynthesis) and sink (grain) relationship as it directly related to N. Similar results were also observed by Ali *et al.* (2016)

3.6 Grain Yield (kg/ha)

Data delineated in table 2 and depicted in Fig. 1 revealed the significant variation in grain yield due to seed priming and fertilizer levels treatments. Results showed that treatment S5 and F2 considerably enhanced the grain yield as compared to other treatment. Grain yield increases due to improves germination, reduces seedling emergence time improves stand establishment, higher plant population, no. of leaves per plant, periodically plant height, cob length and cob girth which encouraged deposition of more photo-assimilates in key plant parts. Similar results were also observed by Ali *et al*. (2016) and Miraj *et al.* (2013). N is the major structural constitute of cells, as N level increased, the rate of vegetative and reproductive growth also increased in plant due to increase in assimilating surface of plant as well as total photosynthesis. In physiological terms, the grain yield of maize is largely governed by source (photosynthesis) and sink (grain) relationship as it directly related to N. These resulted in more grain yield when N was higher. Sufficient availability of nitrogen during the growing season is essential for plant growth processes such as production of chlorophyll and many enzymes and also mediates the utilization of potassium and phosphorus. Similar results were also observed by Ali *et al.* (2016).

3.7 Straw Yield (kg/ha)

Data delineated in Table 2 and depicted in Fig. 1 revealed the significant variation in straw yield due to seed priming and fertilizer levels. Results showed that treatment S5 and F2 considerably enhanced the straw yield which was found to be statistically at par with treatment S3. Whereas, significantly lowest straw yield was recorded with control treatment (no priming) (8067 kg/ha.). Straw yield increases due to improves germination, reduces seedling emergence time improves stand establishment, higher plant population, no. of leaves per plant, periodically plant height, which encouraged deposition of more photo-assimilates in key plant parts. Similar results were also observed by Ali *et al.* (2016) and Miraj *et al.* (2013). Sufficient fertilizer dose favourable for vegetative growth and root development as they received adequate and sufficient nitrogen and phosphorus in proper amount at critical stage. As the results, the plant height and yield attributing characters improved through increased photosynthetic activity of leaves. Similar results were also observed by Ali *et al.* (2016) and Miraj *et al.* (2013).

3.8 Interaction Effect

The data presented in Table 3 indicated that interaction effect of seed priming and fertilizer levels was found significant for grain and straw yield. Grain and straw yield was significantly higher recorded with treatment combination S5F2. Ali *et al.* (2016) confirmed that seed soaking with a 1% phosphorous solution using KH_2PO_4 enhanced fertilizer use efficiency and increased yield and profit for different crops. Similar results were also observed by Patil *et al*. (2018).

CONCLUSION

On the basis of one year experimentation, it can be concluded that *rabi* maize should be seed primed with KH_2PO_4 at 0.5 % for 12 hrs along with application of 100 % RDF (150+60+00 N: P_2O_5: K_2O kg/ha) and 5 t/ha Bio-compost for obtaining higher Plant population, no. of leaves per plant, plant height, seed and straw yield under south Gujrat condition.

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Table 1. Influence of seed priming and fertilizer levels on Plant population, no. of leaves per plant and Plant height on *rabi* maize

Treatments	**Plant population/ha**		**No. of leaves per plant**				**Plant height (cm)**			
	20 DAS	**at Harvest**	**30 DAS**	**60 DAS**	**90 DAS**	**at Harvest**	**30 DAS**	**60 DAS**	**90 DAS**	**at Harvest**
Seed Priming (S)										
S1	76614	76590	8.07	9.6	9.67	9.58	58.63	123.97	151.63	152.28
S2	77160	77148	8.5	10.22	10.73	10.43	65.87	128.73	166.72	167.75
S3	78856	78842	8.95	11.47	11.99	11.63	71.72	136.43	179.99	181.63
S4	78378	78363	8.87	11.22	11.51	11.42	70.33	132.1	175.45	177.88
S5	79017	79007	10.13	12.82	13.07	12.63	75.27	145.43	185.15	186.9
SEm±	79.3	78.45	0.42	0.48	0.49	0.46	2	3.34	2.29	2.33
C.D. at 5%	235.59	233.00	1.24	1.43	1.46	1.36	5.92	9.92	6.87	6.92
Fertilizer Levels (F)										
F1	77931	77917	8.74	10.41	10.65	10.39	68.01	124.71	157.94	159.75
F2	78080	78064	9.07	11.72	12.14	11.89	68.71	141.96	185.63	186.82
SEm±	50.14	49.60	0.26	0.30	0.31	0.29	1.26	2.11	1.45	1.47
C.D. at 5%	NS	NS	NS	0.91	0.92	0.86	NS	6.27	4.3	4.38
S x F	NS	NS	NS	NS	NS	NS	NS	NS	S	S

Where, S1- Control, S2- Water, S3- KCl, S4- $KMnO_4$, S5- KH_2PO_4, F1- 75% RDF, F2 -100% RDF, DAS: Days after sowing; RDF: Recommended Dose of Fertilizer; NS: Non- significant.

Table 2 Effect of various treatments on days to 50% flowering, cob length, cob girth, grain yield and straw yield of rabi maize

Treatments	Days to 50% flowering	Cob Length (cm)	Cob Girth (cm)	Grain yield (kg/ha)	Straw yield (kg/ha)
Seed Priming (S)					
S1	61.6	15.53	13.9	4054	8067
S2	59.3	16.45	14.08	4140	8240
S3	60.5	18.4	15.5	4486	8507
S4	60.6	18.71	14.75	4386	8359
S5	57.5	20.9	15.6	4675	8543
SEm±	**1.51**	**0.66**	**0.36**	**18.87**	**27.83**
C.D. at 5%	**NS**	**1.96**	**NS**	**56.07**	**82.70**
Fertilizer Levels (F)					
F1	61.3	15.91	13.05	4005	7993
F2	58.5	20.08	16.48	4691	8694
SEm±	**0.95**	**0.42**	**0.36**	**11.93**	**17.60**
C.D. at 5%	**NS**	**1.24**	**1.07**	**35.46**	**52.30**
S x F	**NS**	**NS**	**NS**	**S**	**S**

Where, S1- Control, S2- Water, S3- KCl, S4- $KMnO_4$, S5- KH_2PO_4, F1- 75% RDF, F2 -100% RDF, DAS: Days after sowing; RDF: Recommended Dose of Fertilizer; NS: Non- significant.

Table 3. Interaction Effect of various treatments on grain yield and straw yield of *rabi* maize crop

Treatments	Grain yield (kg/ha)		Straw yield (kg/ha)	
Seed Priming (S)	Fertilizer Levels (F)			
	F1	F2	F1	F2
S1	3909	4198	7949	8186
S2	3964	4316	7993	8487
S3	4069	4904	8073	8942
S4	4015	4757	7980	8739
S5	4070	5280	7972	9114
SEm±	**26.9**		**39.7**	
C.D. at 5%	**79.3**		**116.98**	

Where, S1- Control, S2- Water, S3- KCl, S4- $KMnO_4$, S5- KH_2PO_4, F1- 75% RDF, F2 -100% RDF, RDF: Recommended Dose of Fertilizer.

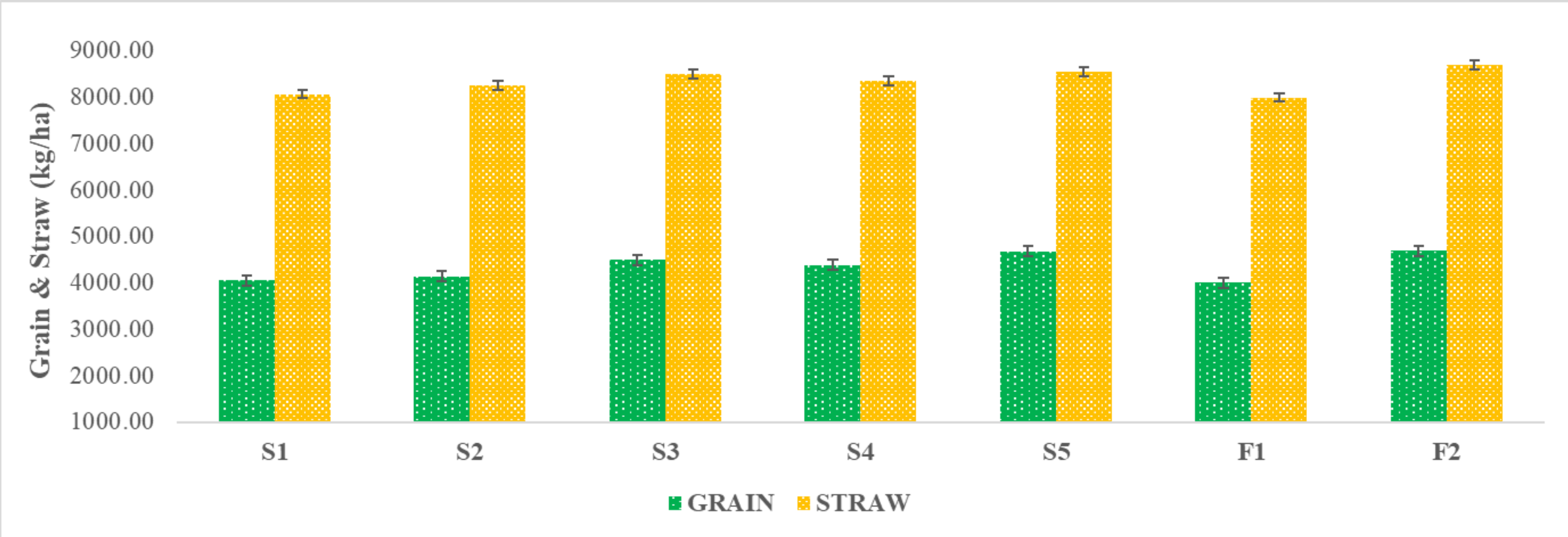

Fig 1. Effect of various treatments on grain yield and straw yield of rabi maize