EFFECT OF SEED PRIMING ON FODDER YIELD OF MAIZE

==

ABSTRACT

The study on effect of seed priming on yield and quality of fodder maize was carried out at Main Forage Research Station, Anand Agricultural University, Anand during the*rabi* season 2020-21.The research comprised of ten treatments and four replications, and it was set up in a randomized block design.The results of the experiments revealed that different seed priming treatments failed to create a significant response on plant population per meter row length at 15 DAS, days to 50% flowering, and plant height at 20 DAS. The growth and yield attributes of fodder maize crop *viz*., periodical plant height at 40 DAS and at harvest, number of leaves per plant, leaf stem ratio, green fodder yield, dry fodder yield,dry matter, crude protein, acid detergent fiber and Neutral detergent fiberat harvest were significantly affected by different seed priming treatments and recorded significantly higher in treatment of Seed priming with $ZnSO_4$ @ 0.5% for 6 hrs. and also reported maximum net realization with its BCR.

Key words: Seed priming, $ZnSO_4$,$FeSO_4$, coconut water, cow urine, $CaCl_2$, KNO_3, KH_2PO_4, Net realization

Introduction

"Forage crops are primarily grown for livestock grazing, and they can be fed to animals, or they can be stored as hay or silage to help achieve production goals" (Jana *et.al*., 2022). "India with only 2.29% of land area of the world, is maintaining nearly 17.4% of world human population and 10.7% of livestock (more than 510 million heads) creating a huge pressure on land, water and other resources" (Roy *et* *al*., 2019). “The major livestock feed resources in our country are grasses, community grazing on common lands and harvested fields, crop residues and cultivated fodder, agricultural by-products, tree leaves from cultivated and uncultivated lands and by-products of agro-industries. Fodder crops are the plant species that are cultivated and harvested for feeding the animals in the form of green forage (cut green and fed fresh), silage (preserved under anerobic condition), hay or other forms. Green fodders are rich and cheapest source of energy, protein, carbohydrates, fibre, minerals and vitamins for dairy animals.Based on the estimate total green fodder requirement is 827.18 million tonnes and total green fodder availability is 734.19 million tonnes that means there is a deficit of 11.24% in the availability of green fodder. Total dry fodder requirement is 426.10 million tonnes and total dry fodder availability is 326.39 million tonnes that means there is a deficit of 23.4% in the availability of dry fodder” (Roy *et al*., 2019).

Maize (*Zea mays* L.) is a one of the most versatile emerging C_4cropgrown round the year under irrigated conditions due to its high production of green forage succulence, sweetness, palatability, nutrition with lactogenic effect milch cattle prefer high delectation towards this crop. It can be harvested at any stage due to non-toxic nature. Maize produces good quality herbaceous fodder with high palatability.

“The poor germination and inconsistent plant population of crop is due to the delay in sowing and reduction in moisture content of soil” (Kale and Takawale, 2019). Seed priming was first proposed by Heydecker (1973). “Seed priming is a simple and low-cost hydration technique in which seeds are partially hydrated to a point of germination process initiation, followed by drying which prevent radicle emergence to a point where pre-germination metabolic activities start without actual germination and then re-dried until close to the original dry weight” (Singh *et al*., 2015). Primed seeds compete with weeds effectively, tolerant to abiotic stress, leading to better stand establishment and yield. Harris *et al.*, (2007) reported that "seed priming led to better establishment and growth, earlier flowering, increase seed tolerance to adverse environment and great yield in maize"."Nowadays various seed priming techniques have been developed which include hydro-priming (water), halo-priming(soaking the seeds in salt solutions like NaCl, KCl, KNO_3, $CaCl_2$ etc.),osmo-priming(Soaking the seeds in osmotic solutions like polyethylene glycol (PEG), glycerol, mannitol and sorbitol), matrix priming(incubating seeds in a matrix/polymer with restricted water use like sand, vermiculite and diatomaceous earth etc.), on-farm priming, hormone or growth enhancer priming (GA_3, salicylic acid, kinetin etc.), micronutrient seed priming (Nutripriming), biopriming or seed treatment with micro-organisms, e.g. *Pseudomonas aureofaciens*, *Trichoderma* sp. etc and nanoparticle priming or coating seeds with nanoparticles" (Pawar and Laware, 2018). "Rapid germination and emergence are essential for successful crop establishment, for which seed priming is an effective technology to enhance rapid and uniform emergence and to achieve high vigour leading to better stand establishment and yield. It is very simple and low cost hydration techniques" (Singh *etal.,* 2015).

MATERIALS AND METHODS

In order to achieve the pre-set objectives of the proposed research, a field experiment was carried out during the *rabi* season of the year 2020-21 on plot no. J-8 at Main Forage Research Station, Anand Agricultural University, Anand (Gujarat).The experimental site had an even topography with moderate slope and decent drainage and the soil is typical of the region's soils, commonly referred to as "*Goradu*" soil. It is alluvial in origin. The soil is very deep and retain a lot of moisture.Soil was ideal for a variety of crops of tropical and sub-tropical regions.

Data on soil analysis indicated that the soil of experimental plot was low in organic carbon (0.25%), medium in available phosphorus (36.20 kg/ha) and medium to high in available potash (285.60 kg/ha). In the present investigation, fodder maize variety African Tall was used.

The observations of the meteorological parameters for the period of investigation during the year 2020-21 recorded at the Meteorological Observatory of Anand Agricultural University, Anand are graphically depicted in Figure 1. The maximum temperature ranged between 25.7 to 32.7 ˚C and minimum temperature ranged between 11.1 to 19.1 ˚C during the crop season. The average humidity range between 55.1 to 78.3%, bright sunshine hours/day between 4.1 to 9.5 hrs, evaporation was 2.0 to 3.7 mm/day and average wind speed range from 1.5 to 4.3 km/hrs. During the experimentation phase, the other weather parameters, such as maximum and minimum temperature, bright sunshine hours, evaporation, mean relative humidity and wind speed were all normal. In general, the weather conditions were congenial during crop season.

The experimental design followed in the present investigation was Randomized Block Design (RBD) encompassing ten treatments and four replications. Ten treatments comprising different priming sources were included in the present experiment. The details of treatments are as follows, **T_1(**Control-no priming),**T_2** (Seed priming with tap water for 6 hrs.),**T_3** (Seed priming with coconut water for 6 hrs.), **T_4** (Seed priming with cow urine @ 2.0% for 6 hrs.),T_5 (Seed priming with 5 days old buttermilk for 6 hrs.),**T_6** (Seed priming with $ZnSO_4$ @ 0.5% for 6 hrs.), **T_7** (Seed priming with $FeSO_4$ @ 0.5% for 6 hrs.),**T_8** (Seed priming with $CaCl_2$ @ 0.5% for 6 hrs.),**T_9** (Seed priming with KNO_3 @ 0.5% for 6 hrs.)and**T_{10}** (Seed priming with KH_2PO_4 @ 0.5% for 6 hrs.). According to the treatments, different seed priming solutions were formulated. The recommended seed rate was used for seed priming and seeds were soaked in these priming solutions for duration of 6 hrs.as shown in Plate-1. Primed seeds were redried until close to the original dry weight (Used tissue paper for drying seed) and treated seeds were sown according to the treatments.During experiment period fodder maize growth and yield attributes, green fodder yield, quality parameters like dry matter, crude protein, dry matter yield, crude protein yield, acid detergent fiber and neutral detergent fiber *etc* observations was taken.

Plate 1: Treating seeds with different priming agents

RESULTS AND DISCUSSION

EFFECT ON GROWTH AND YIELD ATTRIBUTES

An examination of data given in Table 1 revealed that plant population of fodder maize recorded at 15 DAS was not significantly influenced due to different seed priming treatments. It indicated that plant stand was uniformly distributed and satisfactory in all experimental plots. Similar results are in conformity with the findings of Anon. (2018a).

The results (Table1) showed that plant height of fodder maize at 20 DAS was not significantly influenced by various seed priming treatments."Seed priming with $ZnSO_4$ @ 0.5% for 6 hrs. (T_6) recorded significantly higher plant (198.0 and 377.4 cm at 40 DAS and at harvest, respectively) as compared to other treatments. Plant height is a key factor in determining the amount of growth achieved throughout the growing season" (Jana *et.al*., 2022)."Increase in the plant height with seed priming because it produced vigorous seedlings and provided as energetic start to seedling growth. More respiration and carbohydrate metabolism in the seedlings emerged from primed seed resulted in improved growth" (Ali *et al.*,2016and Banerjee *et al.,*2020).

Data presented in Table 1 indicated that seed priming with $ZnSO_4$ @ 0.5% for 6 hrs. (T_6) noted a significantly higher number of leaves/plant (17.93) at harvest.Increasing number of leaves per plant might be due to seed priming treatment enhanced crop growth rate in treated sets, which encouraged the deposition of more photo-assimilates in key plant parts, resulting in an increase in the number of leaves on the plant. These results are in concurrence with the findings of Anon. (2018a) and Banerjee *et al.* (2020).

Days to 50% flowering (Table 1)was not significantly influenced by different seed priming treatments.It was observed from data presented data in Table 1 indicated that the leaf: stem ratio at harvest was significantly influenced by different seed priming treatments and recorded a significantly higher leaf stem ratio (0.57) under treatment T_6 (Seed priming with $ZnSO_4$ @ 0.5% for 6 hrs.), which failed to exert significant difference on number of leaves/plant with respect to T_2 (Seed priming with tap water for 6 hrs.), T_3 (Seed priming with coconut water for 6 hrs.), T_7 (Seed priming with $FeSO_4$ @ 0.5% for 6 hrs.) and T_9 (Seed priming with KNO_3 @ 0.5% for 6 hrs.) at harvest. The increase in the leaf stem ratio might be due to seed priming produced vigorous seedlings which resulted into higher plant height and numerically a greater number of leaves. Similar findings have been reported by Anon. (2016) and Anon. (2018b) in fodder maize."Plant growth was increased dueto seed priming because it generated healthy seedlings and gave them a head start for crop emergence because of more respiration and metabolism of carbohydrate in prime seedling resulted in enhancing dry matter accumulation and yield of crop" (Jana *et.al*., 2022).

EFFECT ON GREEN AND DRY FODDER YIELD

A perusal of data presented in figure-2 revealed that green fodder yield of fodder maize was significantly influenced by different seed priming treatments. Significantly higher green fodder yield (871 q/ha) and dry fodder yield (474 q/ha)observed in treatment T_6 (Seed priming with $ZnSO_4$ @ 0.5% for 6 hrs.). However, it remained statistically at par with treatments T_2 (Seed priming with tap water for 6 hrs.) and T_9 (Seed priming with KNO_3 @ 0.5% for 6 hrs.). The magnitude of mean increase in green fodder yield and dry matter yield with T_6 (Seed priming with $ZnSO_4$ @ 0.5% for 6 hrs.)was 40.93 and 59.59 %, respectively over no priming treatment. Increasing green fodder yield by seed priming might be due to Zn improved the germination and seedling growth of fodder maize. Seed priming stimulates the activities of enzymes like α-amylase, which accelerate the breakdown of food reserves and supply energy to growing embryos. Seed priming improves crop performance by triggering physiological, molecular, and biochemical changes. However, addition of Zn in priming solution further improved emergence and seedling growth, possibly due to the involvement of Zn in the early stages of coleoptile and radicle development. Higher green fodder yield under treatments is attributed due to better development of various growth parameters of crop. These results are in conformity to those reported by Kale and Takawale (2019). Another reason might be due to the priming enzymes involving in seed germination become more active that caused breakdown of metabolites in endosperm of seed resulting in higher plant growth and ultimately increasing green fodder yield (Patel *et.al*., 2021).

EFFECT OF QUALITY PARAMETERS

Perusal data presented in figure-3 indicated that effect of seed priming found significant on quality parameters. Seed priming with Seed priming with $ZnSO_4$ @ 0.5% for 6 hrs. (T_6) reported significantly higher dry matter content (17.35%),dry matter yield (150.1 q/ha), crude protein content (6.97%) and crude protein yield (10.49 q/ha). As compared to no priming (T_1), treatment T_6 (Seed priming with $ZnSO_4$ @ 0.5% for 6 hrs.) reported higher dry matter content (40.48%),dry matter yield (96.20%), crude protein content (37.47%) and crude protein yield (171.76%), while in case of acid detergent fiber and Neutral detergent fiber content, treatment T_6 (Seed priming with $ZnSO_4$ @ 0.5% for 6 hrs.) reported lower acid detergent fiber (37.58%) and Neutral detergent fiber (19.92 %) than control treatment (No priming).Increase in dry matter content might be due to better assimilation rate and better assimilate partitioning in primed seed. Nutrients like N, K and Zn to plants altered metabolic activities due to hormonal effects. Nutrient elements play a critical role in plants that lead to leaf area index and there by increased light interception on crop canopy and ultimately increased the amount of dry matter[Shankrayya*et al*. (2018), Kale and Takawale (2019) and Banerjee *et al*. (2020)]. The increase in crude protein content might be due to increased seed emergence in these treatments. Zinc is essential for the synthesis of plant growth regulators like auxins, and also acts as a metal activator of several enzymes, involved in the synthesis of protein and nucleic acids in plants. Natural and artificial seed priming mobilized and solubilized the globulin and enhances the production of different late embryogenesis abundant protein[Ali *et al.* (2016) andZeeshanMazher*et al.* (2017)].“The enhanced nitrogen absorption was attributable to phosphorus’s favorable effect on root proliferation, anchoring and deep penetration, which allowed the forage maize crop to collect more nutrients from the rhizosphere and transfer them to the forage maize crop, resulting in better dry matter production" (Jana *et.al.,* 2022 and Somasundaram*et.al.,* 2007).

EFFECT ON ECONOMICS

Results revealed that maximum net income (147678 Rs/ha) and BCR (6.6)was obtained under seed priming with $ZnSO_4$ @ 0.5% for 6 hrs.followed by seed priming with KNO_3 @ 0.5% for 6 hrs. (132329 Rs/ha with 6.0 BCR)compared to no priming.

CONCLUSION

According to the field experiment findings of the present investigation, it is concluded that seed priming with zinc sulphate ($ZnSO_4$) @ 0.5% for 6 hrs. or potassium nitrate (KNO_3) @ 0.5% for 6 hrs.secured higher green (871 q/ha) and dry fodder yield (474 q/ha), good fodder quality withhigher net realization.

ACKNOWLEDGEMENT

The authors are sincerely thankful to the Director of Research and Dean PG studies, Anand Agricultural University, Anand, for providing scientific guidance. Research Scientist, Main Forage Research Station, Anand Agricultural University, Anand and Principal and Dean, B. A. College of Agriculture, Anand Agricultural University, Anand for providing the necessary knowledge, facilities and infrastructure to carry out the research investigation.

REFERENCES

Ali, A. A., Iqbal, A., andIqbal, M. A. 2016. Forage maize (*Zea mays* L.) germination, growth and yield get triggered by different seed invigoration techniques. *World Journal of Agricultural Sciences*, 12 (2): 97-104.

Anonymous 2016. Annual report *kharif*-2016 of AICRP on Forage Crops & Utilization, Odisha University of Agriculture & Technology, Bhubaneswar Centre.

Anonymous 2018a.Annual report *kharif*-2018 of AICRP on Forage Crops & Utilization, Anand Agricultural University, Anand Centre.

Anonymous 2018b. Annual report *kharif*-2018 of AICRP on Forage Crops & Utilization, Odisha University of Agriculture & Technology, Bhubaneswar Centre.

Banerjee, S., Jana, K., Mondal, R., Mondal, K., andMondal, A. 2020.Effect of seed priming on growth and yield of hybrid maize-lathyrus sequence under rainfed situation. *Current Journal of Applied Science and Technology*, 39 (1): 126-136.

Harris, D., Rashid, A., Miraj, G., Arif, M., and Shah, H.2007. 'On-farm' seed priming with zinc sulphate solution-A cost-effective way to increase the maize yields of resource-poor farmers. *Field Crops Research*, 102 (2): 119-127.

Jana K., Sarkar A., Mondal R. and Agrawal R.K. (2022). Quality and greed fodder production of forage maize (*Zea mays* L.) as influenced by different seed priming techniques under rained situation. *Journal of crop and weed*: 18(3): 71-77.

KaleR. V andTakawale, P. S. 2019. Seed priming techniques improve germination, forage yield, and economics of fodder maize. *Forage Research*, 45 (3): 229-231.

Kumar, A., Sahoo, B., Panda, A. K., Samal, P., Sarangi, D. N., andSrivastava, S. K. 2019. Forage crops in eastern India for improved livestock productivity.

Patel, H.K., Rathod, P.H., Shroff, J.C.Patel, P.M. and Padheriya, D.R.2021. Green fodder yield and quality of fodder maize as influenced by seed priming. Green Farming, 12(1&2): 46-48.

Pawar, V. A., andLaware, S. L. 2018. Seed priming a critical review. *International Journal of Scientific Research in Biological Sciences*, 5 (5): 94-101.

Roy, A. K., Agrawal, R. K., Bhardwaj, N. R., Mishra, A. K., andMahanta, S. K. 2019. Revisiting National Forage Demand and Availability Scenario.*ICAR-AICRP on Forage Crops and Utilization*, Jhansi, India, 1-21.

Shankrayya, Teggelli, R. G. andPatil, M. 2018. Studies on climate smart intervention on induction of drought tolerance by seed priming with $CaCl_2$ in chickpea growth, yield and quality parameters.*International Journal of Current Microbiology and Applied Sciences.*7 (09): 3510-3514.

Singh, H., Jassal, R. K., Kang, J. S., Sandhu, S. S., Kang, H., andGrewal, K. 2015. Seed priming techniques in field crops-A review. *Agricultural Reviews*, 36 (4).

Somasundaram E., Amanullah M.M., Thirukkumaran K., Chandrasekaran R., Vaijapuri K and Sathyamoorthi K. (2007). Biochemical changes, nitrogen flux and yield of crops due to organic sources of nutrients under maize based cropping system; *J. of appl.Sci.Res.,*1724-1729.

ZeeshanMazher, M., Iqbal, A., Saeed, W., Arsalan, N., andUsman, M 2017. Increasing the quality and yield attributes of late sown forage sorghum through seed priming of different growth substances. *International Journal of Scientific and Research Publications*, 7 (4): 371-377.

Table: 1 Effect of seed priming on growth and yield attributes as well as on economics of fodder maize (*Zea mays* L.)

Treatments	Plant population (Per meter row length)	Periodical plant height (cm)			Number of leaves per plant	Days to 50% flowering	Leaf stem ratio	Net income (`/ha)	BCR
	At 15 DAS	At 20 DAS	At 40 DAS	At Harvest	At Harvest		At Harvest		
T_1: Control (no priming)	9.8	61.6	153.5	284.0	13.56	68	0.43	97633	4.8
T_2: Seed priming with tap water for 6 hrs.	9.9	72.9	193.3	345.6	16.10	66	0.53	123433	5.8
T_3: Seed priming with coconut water for 6 hrs.	10.1	70.6	178.3	336.6	15.28	64	0.50	98102	3.0
T_4: Seed priming with cow urine @ 2.0% for 6 hrs.	10.5	70.5	177.0	328.6	14.95	65	0.49	119633	5.6
T_5: Seed priming with 5 days old buttermilk for 6 hrs.	8.6	65.9	158.9	309.8	13.93	68	0.45	106664	4.9
T_6: Seed priming with $ZnSO_4$ @ 0.5% for 6 hrs.	10.8	75.6	198.0	377.4	17.93	64	0.57	147678	6.6
T_7: Seed priming with $FeSO_4$ @ 0.5% for 6 hrs.	9.7	70.7	186.6	341.8	15.78	64	0.53	121714	5.6
T_8: Seed priming with $CaCl_2$ @ 0.5% for 6 hrs.	9.9	70.2	174.7	326.0	14.73	67	0.47	117544	5.4
T_9: Seed priming with KNO_3 @ 0.5% for 6 hrs.	10.6	73.8	196.4	362.0	16.81	66	0.56	132329	6.0
T_{10}: Seed priming with KH_2PO_4 @ 0.5% for 6 hrs.	9.8	70.1	173.1	319.9	14.31	67	0.46	111559	5.1
S. Em. ±	**0.46**	**3.23**	**9.97**	**16.80**	**0.86**	**1.73**	**0.03**	**-**	**-**
C.D. at 5%	**NS**	**NS**	**28.92**	**48.76**	**2.51**	**NS**	**0.08**	**-**	**-**

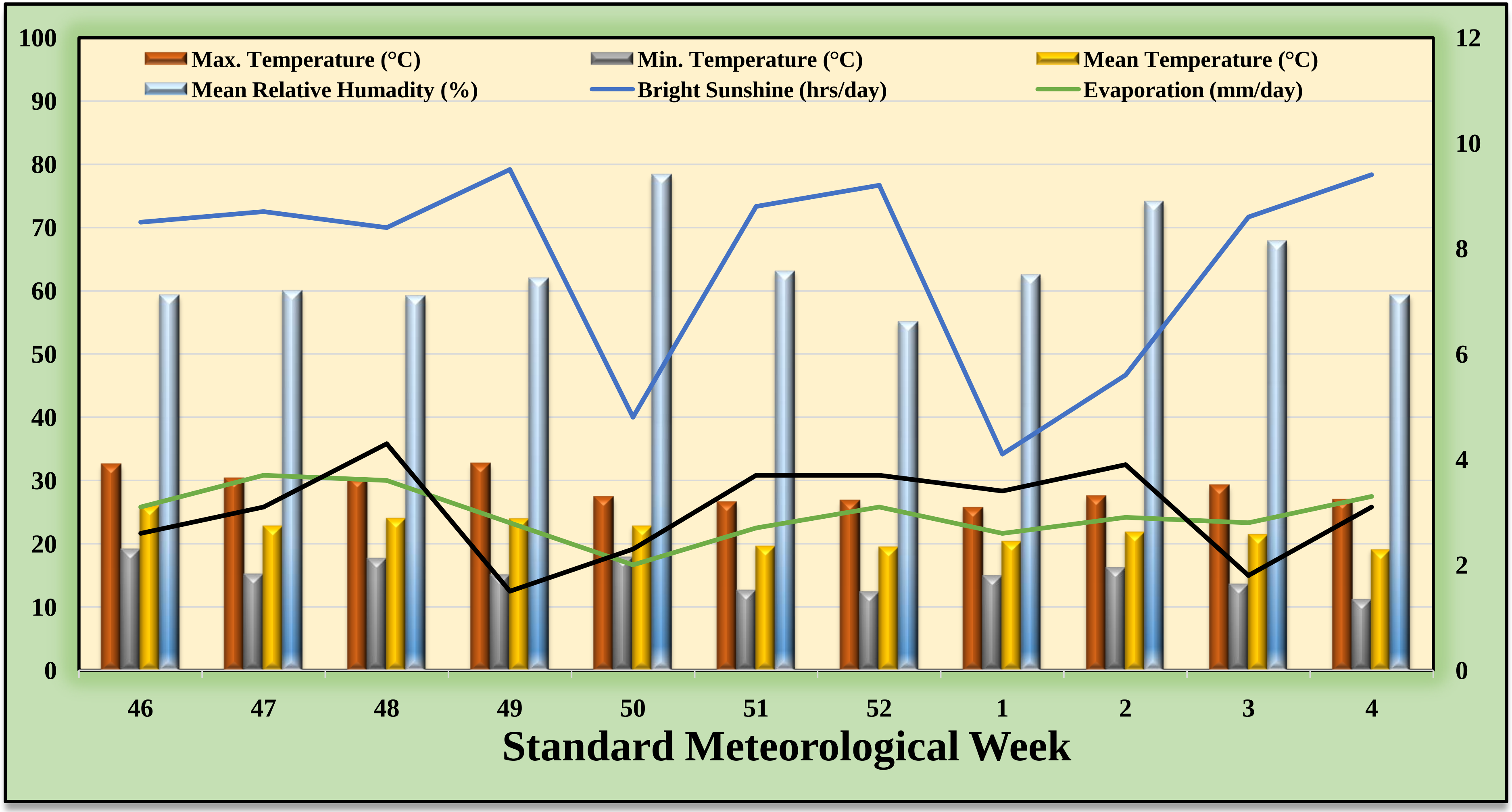

Fig. 1: Mean weekly weather parameters recorded at the Meteorological Observatory, Anand Agricultural University, Anand for the crop season *rabi*, 2020-2021

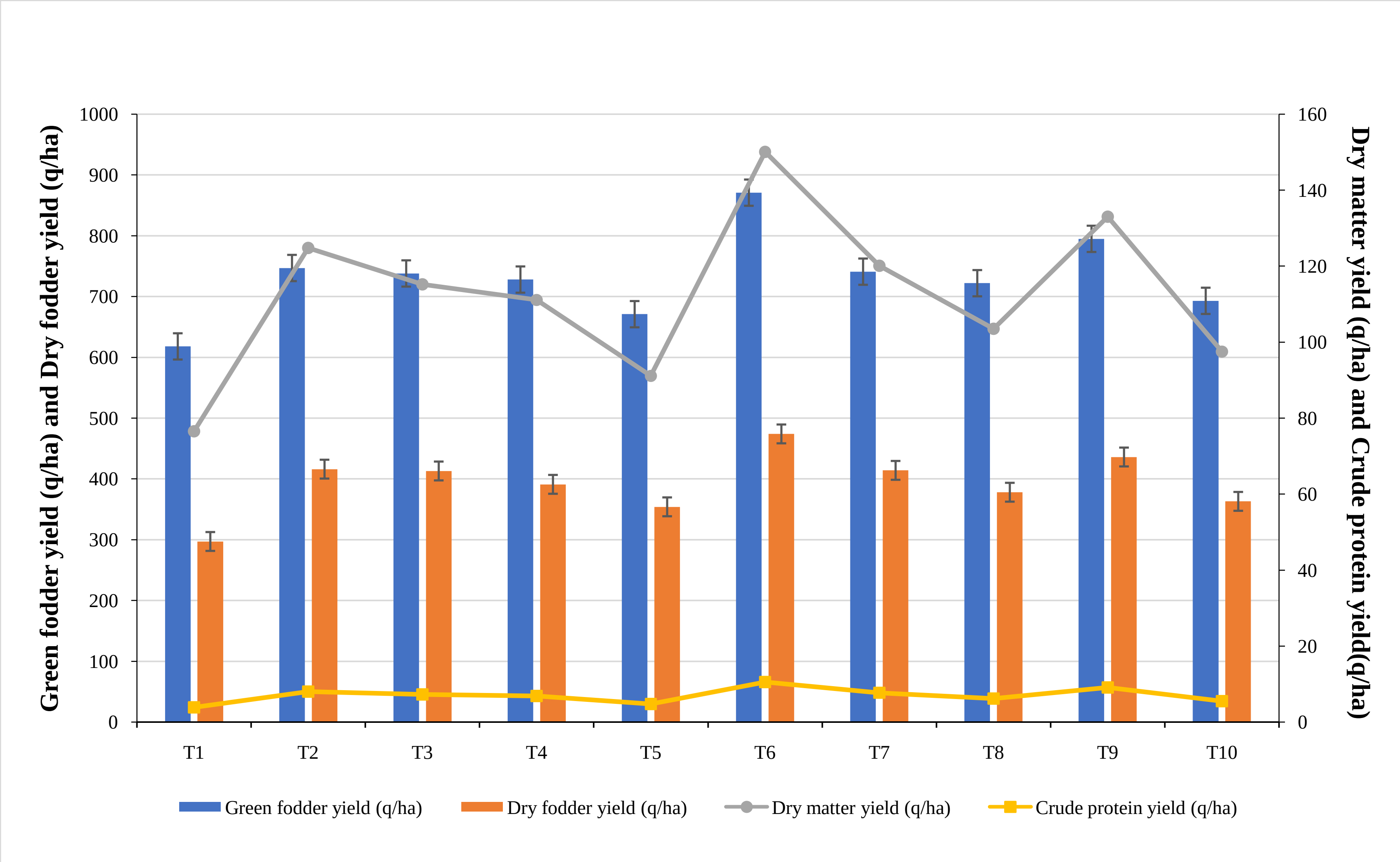

Fig. 2: Effect of seed priming on green fodder yield, dry fodder yield, dry matter yield and crude protein yield

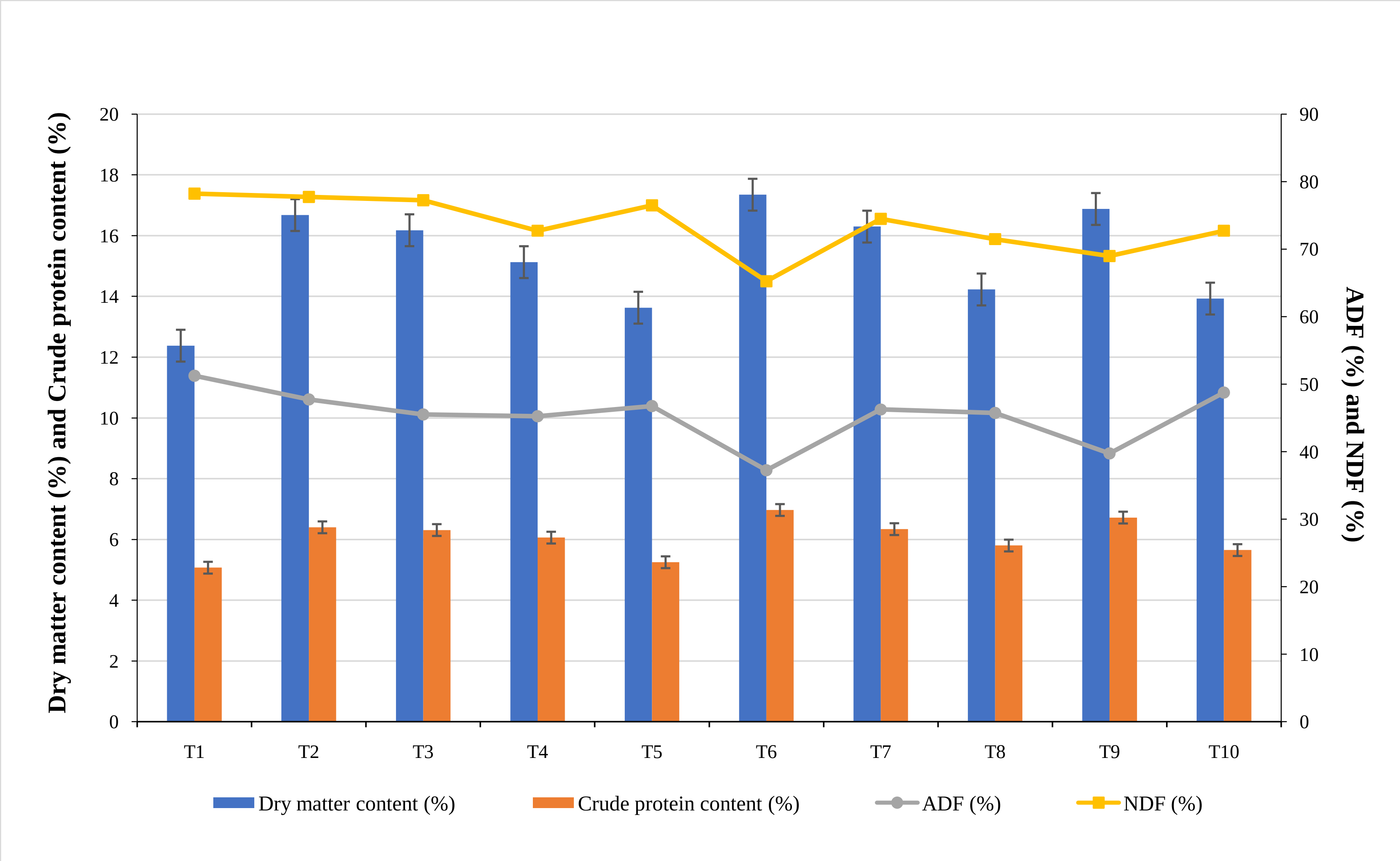

Fig. 3: Effect of seed priming on dry matter content, crude protein content, ADF and NDF