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Effect of Sowing Methods, Weed Management and Growth Promoters on Yield and Quality Behavior of *Kharif* Maize (*Zea mays L*)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation was carried out during two consecutive *kharif* season in years 2022 and 2023 at students. Instructional Farm, Department of Agronomy, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U. P). The experiment was laid out in Split Plot Design keeping sowing methods in main plot and weed management practices in sub plots with growth promoters in sub – sub plots with three replications. There was two sowing methods viz; Conventional methods (S_1) and Ridge methods (S_2). Whereas weed management practices were five, viz; Weed Free (W_1), Weedy Check (W_2), Atrazine Pre-emergence @ 1.25 Kg /ha (W_3), Halosulfuron methyl Post-emergence @ 65g a.i./ha (W_4), Atrazine Pre-emergence @ 0.75 l/ha + Halosulfuron methyl Post-emergence @ 35g ai./ha (W_5). and there was Growth promoters' practices were three viz; Gibberellic acid (Sayish) (G_1), Amino acid + Humic acid (Spring ever) (G_2), Cytokinins + Enzymes (Ambition) (G_3). The experiment was shown on 10th July during 2022 and 13rd July during 2023 using hybrid maize DKC-9144. The crop was harvested at full ripe stage on 11 October and 14 October, in 2022 and 2023, respectively. The highest grain yield, biological yield, stower yield, harvesting index, protein content and protein yield was found under the treatment of S_2 (Ridge method) in sowing method, treatment W_2 (weed free) in weed control methods and treatment G_3 (Cytokinins + Enzymes) in plant growth promotor.

Keywords: Conventional methods; ridge method; weed management; growth promoters.

1. INTRODUCTION

Maize (*Zea mays* L.) is one of the most versatile crops with wider adaptability in various agro ecologies. It has the highest genetic yield potential among the food grain crops. Maize is an important cereal crop in terms of the agricultural economy, both as food for human and feed for animals. It is a miracle crop and known as 'Queen of cereals' due to its widespread uses. Maize serves as a basic raw material and an ingredient to numbers of industrial products that include starch, oil, protein, beverages, food sweeteners, pharmaceutical, cosmetic, textile, and gum, packaging, and paper industries. Globally, it occupies nearly 207.25 million hectares of land in about 160 countries and 1217.30 million tonnes of production with average yield of 5.87 metric tonneha^{-1}In India maize is the third most important cereal crop after rice and wheat, cultivated on 10.10 million hectares area with production of 33.60 million tonnes with average productivity of 3.33 metric tons ha^{-1} [1]. Method of sowing has a great role to play in increasing maize yield. Our farmers generally use the broadcast method of sowing with so many disadvantages i.e. uneven distributions of seeds, depth, and seed lying scattered being picked up by birds [2,3]. Sowing of maize crop in many different methods like Dibbling, drilling and broadcasting in flat and ridges. Different planting methods including flat sowing, ridge sowing are employed for maize. Singh et al. [4] already reported that maize and sorghum grown on ridges yielded 14 to 106 percent and 6 to 59 percent respectively compared to planting on flat beds. Ridging also improve seedling emergence as well as plant fresh weight. Maximum 1000 grain weight, plant height and grain yield was obtained with ridge sowing [5,6-8]. Weeds usually reduces crop yield up to 31.5% (22.7% in Rabi and in kharif 36.5%). But as farmers adopt some kind of weeding on their crop field, a conservative estimate of 10% loss in crop yields may be taken as more realistic, hand weeding is most effective if done in time, though it is costly and time consuming. Apart from this, labourers are not available for weeding sowing to other agricultural operation going on simultaneously. Weeds emerge fast and grow rapidly competing with the crop severely for growth resources viz., nutrients, moisture, sunlight, and space during entire vegetative and early reproductive stages of maize crop [9,10]. Gibberellins are probably one of the growth regulators that have a significant effect on flowering. Dwarfing depends upon gibberellin deficiency and dwarfing gene effects on gibberellin biosynthesis [11]. The method of spraying plant growth regulators (PGRs) is used to promote the formation of maize biomass; therefore, high-quality maize can be produced. By controlling the transmission and metabolism of plant endogenous hormone signals, PGRs can improve plant shape and yield. So, by applying gibberellic acid on dwarf maize mutant, they showed normal growth after hormone treatment. In addition, long stems have more bioactive gibberellin than short stems [12].

2. METHODS AND MATERIALS

A field experiment was conducted during two consecutive *kharif* season of 2021 and 2022 at Student's Instructional Farm, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur to assess the most suitable hybrid maize variety for effect of sowing methods, weed management and growth promoters on weed dynamics, growth and economics. The treatments comprised three factors of **Main plot:** Sowing Method -2 treatments two sowing methods i.e. Conventional Method (S_1), Ridge Method (S_2) **and Sub Plot:** Weed Managements - 5 of Weed Free (W_1), Weedy Check (W_2), Atrazine Pre-emergence @ 1.25 Kg/ha) (W_3), Halosulfuron methyl Post-emergence @ 65g a.i./ha (W_4), Atrazine Pre-emergence @ 0.75 l/ha + Halosulfuron methyl Post-emergence @ 35g ai./ha (W_5), and **Sub -Sub Plot**: Growth Promoters -3 Gibberellic acid (Sayish), Amino acid + Humic acid (Spring ever), Cytokinins + Enzymes (Ambition) + making thirteen treatment combinations assigned to 90 plots which was laid out in split plot Design with three replications. The experiment was sowon on 10th July during 2022 and 13rd July during 2023 using hybrid maize DKC-9144. The crop was harvested at full ripe stage on 11 October and 14 October, in 2022 and 2023, respectively. The available Nitrogen in soil was 189.12 kg ha^{-1}, which was estimated by the Alkaline permanganate method given by Subbiah and Asija [13] the available Phosphorus was 14.60 kg ha^{-1} estimated by Olsen's method given by Olsen et al. [14]. The available K was 167.31 kg ha^{-1} which was estimated by the Flame photometer method given by Black (1965). The available S was 18.50 kg ha^{-1} which was estimated by the calcium extraction method given by William and Steinberg [15]. The soil of the experimental field was clayey in texture and slightly alkaline in pH (8.12), by using Glass Electrode pH was examined using Piper's technique. The electrical conductivity (EC) of the soil was 0.39 (d S m^{-1}) estimated following method No. 4, USDA Hand Book by Piper [16]. Organic carbon in the soil was 0.42% which was estimated by rapid titration (wet oxidation) method given by Walkley and Black [17]. The recommended dose of fertilizer (NPK: 120:60:40 Kg ha^{-1} was applied uniformly in each plot. Nitrogen was applied as treatments through urea, half as basal dose and remaining half at 45 days ofter sowing. Phosphorus and potassium were applied respectively.

3. RESULTS AND DISCUSSION

3.1 Grain Yield (q ha^{-1})

The effect of different sowing methods on grain yield of maize during kharif season recorded of non-significant (Table 1). At different days after sowing the ridge method recorded greater grain yield in both the year 2022 and 2023 of experiment over the conventional method of sowing. In 2022, the ridge method (S_2) recorded 65.42 of grain yield which is higher than conventional methods (S_1) method of sowing. In 2023 the ridge method recorded 67.03 (qha^{-1}) grain yields which is also higher than conventional method of sowing. Similarly, in pooled data of both the year the ridge method recorded higher grain yield in comparison of conventional method of sowing which are 66.17 (q ha^{-1}).

Applied different weed management practices reflecting varied grain yield in both the year of experiment. In 2022 the highest grain yield was recorded in treatment (W_2) weed free 66.88. which is greater than the other methods of weed management. And lowest gain yield was found in treatment (W_1) weedy check 61.57. Further, in the year 2023 the grain yield of weed free treatment (W_2) of experiment recorded 68.34 (q ha^{-1}) this is also greater than the other methods of weed management. And lowest gain yield was found in treatment (W_1) weedy check 62.93. While, the pooled data of grain yield the weed free treatment (W_2) also recorded highest grain yield 67.61 (q ha^{-1}) in comparison to other methods of weed management. Subsequently, among the herbicide applied treatment the treatment Atrazine Pre-emergence @ 0.75l/ha + Halosulfuron methyl Post-emergence @ 35gai./ha (W_5) recoded maximum grain yield after weed free treatment (W_2) of experiment. In the year 2022, The Atrazine Pre-emergence @0.75l/ha + Halosulfuron methyl Post-emergence @ 35gai./ha (W_5) treatment reported greater grain yield of 66.09 (q ha^{-1}) over other herbicide applied treatment. While, in the year 2023, Atrazine Pre-emergence @0.75l/ha + Halosulfuron methyl Post-emergence @ 35gai./ha (W_5) treatment reported 67.91 (q ha^{-1}) of grain yield. The pooled data of Atrazine Pre-emergence @0.75l/ha + Halosulfuron methyl Post-emergence @ 35gai./ha (W_5) treatment of experiment also reflected superior results in regard of grain yield of 67.00 (q ha^{-1}) over rest of the herbicide applied treatment.

Table 1. Effect of sowing methods, weed management and growth promoters on grain yield, stover yield, biological yield and harvest index (%) of maize during 2022 and 2023

Treatment	Grain yield (qha^{-1})			Stover Yield (q ha^{-1})			Biological Yield (q ha^{-1})			Harvest index (%)		
	2022	2023	pooled	2022	2023	pooled	2022	2023	pooled	2022	2023	pooled
Sowing Method												
S_1	64.30	65.85	65.14	114.89	116.80	115.97	179.31	182.66	180.98	35.29	35.44	35.42
S_2	65.42	67.03	66.17	116.13	117.92	117.10	181.44	184.95	183.20	35.36	35.46	35.48
SE(d)	**2.532**	**0.073**	**0.283**	**0.075**	**0.024**	**0.139**	**0.163**	**0.080**	**0.090**	**0.027**	**0.034**	**0.035**
CD at 5 %	**0.226**	**0.318**	**0.229**	**0.329**	**0.104**	**0.605**	**0.713**	**0.349**	**0.391**	**NS**	**NS**	**NS**
Weed management												
W_1	61.57	62.93	62.25	110.70	112.46	111.64	172.27	175.39	173.83	35.09	35.21	35.15
W_2	66.88	68.34	67.61	117.81	119.73	119.06	184.70	188.07	186.39	35.58	35.73	35.66
W_3	64.55	66.21	65.38	115.52	117.41	116.53	180.07	183.62	181.85	35.22	35.43	35.33
W_4	65.21	66.83	66.02	116.43	118.42	117.51	181.65	185.26	183.46	35.29	35.47	35.45
W_5	66.09	67.91	67.00	117.09	118.78	117.95	183.19	186.70	184.94	35.45	35.76	35.68
SE(d)	**0.758**	**0.055**	**0.385**	**0.074**	**0.075**	**0.197**	**0.130**	**0.120**	**0.129**	**0.006**	**0.007**	**0.140**
CD at 5 %	**1.519**	**0.110**	**0.772**	**0.149**	**0.150**	**0.394**	**0.261**	**0.258**	**0.259**	**0.013**	**0.013**	**0.280**
Growth Promoters												
G_1	64.96	66.71	65.83	115.35	117.50	116.52	180.50	184.20	182.35	35.37	35.60	35.49
G_2	63.62	65.36	64.49	114.22	116.05	115.35	177.84	181.42	179.63	35.14	35.40	35.25
G_3	66.01	67.26	66.64	116.78	118.54	117.74	182.79	185.81	184.30	35.47	35.56	35.62
SE(d)	**0.587**	**0.043**	**0.299**	**0.057**	**0.058**	**0.153**	**0.101**	**0.099**	**0.100**	**0.005**	**0.005**	**0.108**
CD at 5 %	**1.176**	**0.085**	**0.598**	**0.115**	**0.116**	**0.306**	**0.202**	**0.202**	**0.201**	**0.010**	**0.010**	**0.217**
CD at 5 % for interactions	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

S_1 = Conventional Method, S_2 = Ridge Method

W_1 = Weedy Check, W_2 = Weed Free, W_3 = Atrazine Pre-emergence @ 1.25 Kg/ha^{-1}), W_4 = Halosulfuron methyl Post-emergence @ 65g a.i./ha, W_5 = Atrazine Pre-emergence @ 0.75 l/ha + Halosulfuron methyl Post-emergence @ 35g ai./ha

G_1 = Gibberellic acid (Sayish), G_2 = Amino acid + Humic acid (Spring ever), G_3 = Cytokinins + Enzymes (Ambition)

Table 2. Effect of sowing methods, weed management and growth promoters on quality parameters of maize during 2022 and 2023

Treatment	Protein content (%)			Protein yield (kg ha^{-1})		
	2022	2023	Pooled	2022	2023	Pooled
Sowing Method						
S_1	9.90	10.02	9.96	648.82	671.68	661.54
S_2	9.93	10.06	9.99	659.90	686.04	674.53
SE(d)	**0.008**	**0.008**	**0.010**	**0.222**	**0.707**	**0.445**
CD at 5 %	**NS**	**NS**	**NS**	**0.967**	**3.082**	**1.940**
Weed management						
W_1	9.85	9.94	9.89	617.29	637.69	640.42
W_2	9.98	10.11	10.04	679.14	703.01	682.41
W_3	9.88	10.01	9.94	648.92	674.40	661.76
W_4	9.91	10.04	9.97	657.64	682.92	673.68
W_5	9.95	10.08	10.01	668.82	696.26	681.92
SE(d)	**0.002**	**0.002**	**0.002**	**0.645**	**0.663**	**4.59**
CD at 5 %	**0.004**	**0.004**	**0.003**	**1.293**	**1.328**	**9.214**
Growth Promoters						
G_1	9.91	10.04	9.98	655.29	681.48	668.75
G_2	9.88	10.00	9.94	639.65	665.65	658.24
G_3	9.94	10.07	10.01	668.14	689.45	677.13
SE(d)	**0.001**	**0.002**	**0.001**	**0.500**	**0.513**	**3.56**
CD at 5 %	**0.003**	**0.003**	**0.003**	**1.001**	**1.029**	**7.13**
CD at 5 % for interaction	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Among all the growth promoters applied treatment the treatment Cytokinins + Enzymes (Ambition) (G_3) recorded superior grain yield of 66.01 (q ha^{-1}) in 2022. And 67.26 in 2023 respectively. The pooled data of grain yield of experiment also showed superior in Cytokinins + Enzymes (Ambition) (G_3) treatment which is grain yield of 66.64 (q ha^{-1}) in comparison of other treatment. While statistically the effect of all the growth promoters on grain yield of maize at days after sowing recorded significant. These results are corroborated with the findings of Chavan [18], Halli and Angadi [19], Joshi et al. [20] and Yadav et al. [21].

The interaction of all effect of sowing methods, weed management and growth promoters on yield to produce non-significant variation in grain yield (primary and secondary) in both year and pooled data of study.

3.2 Stover Yield (q ha^{-1})

The effect of different sowing methods on stover yield of maize during kharif season recorded of non-significant (Table 1). At different days after sowing the ridge method recorded greater stover yield in both the year 2022 and 2023 of experiment over the conventional method of sowing. In 2022, the ridge method (S_2) recorded 116.13 (q ha^{-1}) of stover yield which is higher than conventional methods (S_1) method of sowing. In 2023 the ridge method recorded 117.92 (q ha^{-1}) stover yield which is also higher than conventional method of sowing. Similarly, in pooled data of both the year the ridge method recorded higher stover yield in comparison of conventional method of sowing which are 117.10 (q ha^{-1}).

Applied different weed management practices reflecting varied grain yield in both the year of experiment. In 2022 the highest grain yield was recorded in treatment (W_2) weed free 117.81. which is greater than the other methods of weed management. And lowest gain yield was found in treatment (W_1) weedy check 110.70. Further, in the year 2023 the grain yield of weed free treatment (W_2) of experiment recorded 119.73 (q ha^{-1}) this is also greater than the other methods of weed management. And lowest gain yield was found in treatment (W_1) weedy check 112.46. While, the pooled data of grain yield the weed free treatment (W_2) also recorded highest grain yield 119.06 (q ha^{-1}) in comparison to other methods of weed management. Subsequently, among the herbicide applied treatment the treatment Atrazine Pre-emergence @ 0.75l/ha + Halosulfuron methyl Post-emergence @ 35gai./ha (W_5) recoded maximum grain yield after weed free treatment (W_2) of experiment. In the year 2022, The Atrazine Pre-emergence @0.75l/ha + Halosulfuron methyl Post-emergence @ 35gai./ha (W_5) treatment reported greater grain yield of 117.09 (q ha^{-1}) over other herbicide applied treatment. While, in the year 2023, Atrazine Pre-emergence @0.75l/ha + Halosulfuron methyl Post-emergence @ 35gai./ha (W_5) treatment reported 118.78 (qha^{-1}) of grain yield. The pooled data of Atrazine Pre-emergence @0.75l/ha + Halosulfuron methyl Post-emergence @ 35gai./ha (W_5) treatment of experiment also reflected superior results in regard of grain yield of 117.95 (q ha^{-1}) over rest of the herbicide applied treatment.

Among all the growth promoters applied treatment the treatment Cytokinin's + Enzymes (Ambition) (G_3) recorded superior grain yield of 116.78 (q ha^{-1}) in 2022. And 118.54 in 2023 respectively. The pooled data of grain yield of experiment also showed superior in Cytokinin's + Enzymes (Ambition) (G_3) treatment which is grain yield of 117.74 (q ha^{-1}) in comparison of other treatment. While statistically the effect of all the growth promoters on grain yield of maize at days after sowing recorded significant. These results are corroborated with the findings of Rao et al. [22].

The interaction of all effect of sowing methods, weed management and growth promoters on yield to produce non-significant variation in stover yield (primary and secondary) in both year and pooled data of study.

3.3 Biological Yield (q ha^{-1})

The effect of different sowing methods on biological yield of maize during kharif season recorded of significant (Table 1). At different days after sowing the ridge method recorded greater biological yield in both the year 2022 and 2023 of experiment over the conventional method of sowing. In 2022, the ridge method (S_2) recorded 181.44 (q ha^{-1}) biological yield which is higher than conventional methods (S_1) method of sowing. In 2023 the ridge method recorded 184.95 (q ha^{-1}) biological yield which is also higher than conventional method of sowing. Similarly, in pooled data of both the year the ridge method recorded higher biological yield in comparison of conventional method of sowing which are 183.20 (q ha^{-1}).

Applied different weed management practices reflecting varied grain yield in both the year of experiment. In 2022 the highest grain yield was recorded in treatment (W_2) weed free 184.70 which is greater than the other methods of weed management. And lowest gain yield was found in treatment (W_1) weedy check 172.27. Further, in the year 2023 the grain yield of weed free treatment (W_2) of experiment best recorded 188.07 (q ha^{-1}) this is also greater than the other methods of weed management. And lowest gain yield was found in treatment (W_1) weedy check 175.39. While, the pooled data of grain yield the weed free treatment (W_2) also recorded highest grain yield 186.39 (q ha^{-1}) in comparison to other methods of weed management. Subsequently, among the herbicide applied treatment the treatment Atrazine Pre-emergence @ 0.75l/ha + Halosulfuron methyl Post-emergence @ 35gai./ha (W_5) recoded maximum grain yield after weed free treatment (W_2) of experiment. In the year 2022, The Atrazine Pre-emergence @0.75l/ha + Halosulfuron methyl Post-emergence @ 35gai./ha (W_5) treatment reported greater grain yield of 183.19 (q ha^{-1}) over other herbicide applied treatment. While, in the year 2023, Atrazine Pre-emergence @0.75l/ha + Halosulfuron methyl post-emergence @ 35gai./ha (W_5) treatment reported 186.70 (q ha^{-1}) of grain yield. The pooled data of Atrazine Pre-emergence @0.75l/ha + Halosulfuron methyl post-emergence @ 35gai. /ha (W_5) treatment of experiment also reflected superior results in regard of grain yield of 184.94 (qha^{-1}) over rest of the herbicide applied treatment.

Among all the growth promoters applied treatment the treatment Cytokinin's + Enzymes (Ambition) (G_3) recorded superior grain yield of 182.79 (q ha^{-1}) in 2022. And 185.81 in 2023 respectively. The pooled data of grain yield of experiment also showed superior in Cytokinin's + Enzymes (Ambition) (G_3) treatment which is grain yield of 184.30 (q ha^{-1}) in comparison of other treatment. While statistically the effect of all the growth promoters on grain yield of maize at days after sowing recorded significant.

The interaction of all effect of sowing methods, weed management and growth promoters on yield to produce non-significant variation in biological yield (primary and secondary) in both year and pooled data of study.

3.4 Harvest Index (%)

The effect of different sowing methods on harvest index of maize during kharif season recorded of non-significant (Table 1). At different days after sowing the ridge method recorded greater harvest index in both the year 2022 and 2023 of experiment over the conventional method of sowing. In 2022, the ridge method (S_2) recorded 35.45 (%) of harvest index which is higher than conventional methods (S_1) method of sowing. In 2023 the ridge method recorded 35.47 (%) harvest index which is also higher than conventional method of sowing. Similarly, in pooled data of both the year the ridge method recorded higher harvest index in comparison of conventional method of sowing which are 35.46 (%).

Applied different weed management practices reflecting varied grain yield in both the year of experiment. In 2022 the highest grain yield was recorded in treatment (W_2) weed free 35.58 which is greater than the other methods of weed management. And lowest gain yield was found in treatment (W_1) weedy check 35.09. Further, in the year 2023 the grain yield of weed free (W_2) treatment of experiment best recorded 35.76 (q ha^{-1}) this is also greater than the other methods of weed management. And lowest gain yield was found in treatment (W_1) weedy check 35.21. While, the pooled data of grain yield the weed free (W_2) treatment also recorded highest grain yield 35.67 (q ha^{-1}) in comparison to other methods of weed management. Subsequently, among the herbicide applied treatment the treatment Atrazine Pre-emergence @ 0.75l/ha + Halosulfuron methyl Post-emergence @ 35gai./ha (W_5) recoded maximum grain yield after weed free treatment (W_2) of experiment. In the year 2022, The Atrazine Pre-emergence @0.75l/ha + Halosulfuron methyl Post-emergence @ 35gai./ha (W_5) treatment reported greater grain yield of 35.45 (q ha^{-1}) over other herbicide applied treatment. While, in the year 2023, Atrazine Pre-emergence @0.75l/ha + Halosulfuron methyl post-emergence @ 35gai./ha (W_5) treatment reported 35.76 (q ha^{-1}) of grain yield. The pooled data of Atrazine Pre-emergence @0.75l/ha + Halosulfuron methyl post-emergence @ 35gai. /ha (W_5) treatment of experiment also reflected superior results in regard of grain yield of 35.59 (q ha^{-1}) over rest of the herbicide applied treatment.

Among all the growth promoters applied treatment the treatment Cytokinin's + Enzymes (Ambition) (G_3) recorded superior grain yield of 35.47 (q ha^{-1}) in 2022. And 35.56 in 2023 respectively. The pooled data of grain yield of experiment also showed superior in Cytokinin's +

Enzymes (Ambition) (G_3) treatment which is grain yield of 35.62 (q ha^{-1}) in comparison of other treatment. While statistically the effect of all the growth promoters on grain yield of maize at days after sowing recorded significant. These results are corroborated with the findings of Rao et al. [22].

The interaction of all effect of sowing methods, weed management and growth promoters on yield to produce non-significant variation in harvesting index (primary and secondary) in both year and pooled data of study.

3.5 Protein Content (%)

The effect of different sowing methods on protein content of maize during kharif season recorded of non-significant (Table 2). At different days after sowing the ridge method recorded greater protein content in both the year 2022 and 2023 of experiment over the conventional method of sowing. In 2022, the ridge method (S_2) recorded 9.93 (%) of protein content which is higher than conventional methods (S_1) method of sowing. In 2023 the ridge method recorded 10.06 (%) protein content which is also higher than conventional method of sowing. Similarly, in pooled data of both the year the ridge method recorded higher protein content (%) in comparison of conventional method of sowing which are 9.99.

Applied different weed management practices reflecting varied protein content in both the year of experiment. In 2022 the highest protein content was recorded in treatment (W_2) weed free 9.98 %. which is greater than the other methods of weed management. And lowest protein content was found in treatment (W_1) weedy check 9.85%. Further, in the year 2023 the protein content of weed free (W_2) treatment of experiment best recorded 10.11%. this is also greater than the other methods of weed management. And lowest protein content was found in treatment (W_1) weedy check 9.94 %. While, the pooled data of protein content the weed free (W_2) treatment also recorded highest protein content 10.04 % in comparison to other methods of weed management. Subsequently, among the herbicide applied treatment the treatment Atrazine Pre-emergence @ 0.75l/ha + Halosulfuron methyl Post-emergence @ 35gai./ha (W_5) recoded maximum protein content after weed free treatment (W_2) of experiment. In the year 2022, The Atrazine Pre-emergence @0.75l/ha + Halosulfuron methyl Post-emergence @ 35gai./ha (W_5) treatment reported greater protein content of 9.95 % over other herbicide applied treatment. While, in the year 2023, Atrazine Pre-emergence @0.75l/ha + Halosulfuron methyl post-emergence @ 35gai./ha (W_5) treatment reported 10.08 % of protein content. The pooled data of Atrazine Pre-emergence @0.75l/ha + Halosulfuron methyl post-emergence @ 35gai. /ha (W_5) treatment of experiment also reflected superior results in regard of protein content of 10.01 % over rest of the herbicide applied treatment.

Among all the growth promoters applied treatment the treatment Cytokinin's + Enzymes (Ambition) (G_3) recorded superior protein content of 9.94 % in 2022. And 10.07 % in 2023 respectively. The pooled data of protein content of experiment also showed superior in Cytokinin's + Enzymes (Ambition) (G_3) treatment which is protein content of 10.01 % in comparison of other treatment. While statistically the effect of all the growth promoters on grain yield of maize at days after sowing recorded significant.

The interaction of all effect of sowing methods, weed management and growth promoters on yield to produce non-significant variation in protein content (primary and secondary) in both year and pooled data of study.

3.6 Protein Yield (kg ha^{-1})

The effect of different sowing methods on protein yield of maize during kharif season recorded of significant (Table 2). At different days after sowing the ridge method recorded greater protein yield in both the year 2022 and 2023 of experiment over the conventional method of sowing. In 2022, the ridge method (S_2) recorded 659.90 (kg ha^{-1}) of protein yield which is higher than conventional methods (S_1) method of sowing. In 2023 the ridge method recorded 686.04 (kg ha^{-1}) protein yield which is also higher than conventional method of sowing. Similarly, in pooled data of both the year the ridge method recorded higher protein yield in comparison of conventional method of sowing which are 674.53 (kg ha^{-1}).

Applied different weed management practices reflecting varied protein yield in both the year of experiment. In 2022 the highest protein yield was recorded in treatment (W_2) weed free 679.14 (kg ha^{-1}). which is greater than the other methods of weed management. And lowest protein yield was found in treatment (W_1) weedy check 617.29 (kg ha^{-1}). Further, in the year 2023 the protein yield

of weed free (W_2) treatment of experiment best recorded 703.01 (kg ha^{-1}). this is also greater than the other methods of weed management. And lowest protein yield was found in treatment (W_1) weedy check 637.69 (kg ha^{-1}). While, the pooled data of protein yield the weed free (W_2) treatment also recorded highest protein yield 682.41 (kg ha^{-1}) in comparison to other methods of weed management. Subsequently, among the herbicide applied treatment the treatment Atrazine Pre-emergence @ 0.75l/ha + Halosulfuron methyl Post-emergence @ 35gai./ha (W_5) recoded maximum protein yield after weed free treatment (W_2) of experiment. In the year 2022, The Atrazine Pre-emergence @0.75l/ha + Halosulfuron methyl Post-emergence @ 35gai./ha (W_5) treatment reported greater protein yield of 668.82 (kg ha^{-1}) over other herbicide applied treatment. While, in the year 2023, Atrazine Pre-emergence @0.75l/ha + Halosulfuron methyl post-emergence @ 35gai./ha (W_5) treatment reported 696.26 (kg ha^{-1}) of protein yield. The pooled data of Atrazine Pre-emergence @0.75l/ha + Halosulfuron methyl post-emergence @ 35gai. /ha (W_5) treatment of experiment also reflected superior results in regard of protein yield of 681.92 (kg ha^{-1}) over rest of the herbicide applied treatment.

Among all the growth promoters applied treatment the treatment Cytokinin's + Enzymes (Ambition) (G_3) recorded superior protein yield of 668.14 (kg ha^{-1}) in 2022. And 689.45 (kg ha^{-1}) in 2023 respectively. The pooled data of protein yield of experiment also showed superior in Cytokinin's + Enzymes (Ambition) (G_3) treatment which is protein yield of 677.13 (kg ha^{-1}) in comparison of other treatment. While statistically the effect of all the growth promoters on protein yield of maize at days after sowing recorded significant.

The interaction of all effect of sowing methods, weed management and growth promoters on yield to produce non-significant variation in protein yield (primary and secondary) in both year and pooled data of study.

4. CONCLUSION

The highest grain yield, biological yield, stower yield, harvesting index, protein content and protein yield was found under the treatment of S_2 (Ridge method) in sowing method, treatment W_2 (weed free) in weed control methods. Subsequently, among the herbicide applied treatment the treatment Atrazine Pre-emergence @ 0.75l/ha + Halosulfuron methyl Post-emergence @ 35gai./ha (W_5) recoded maximum grain yield after weed free treatment (W_2) of experiment and treatment G_3 (Cytokinins + Enzymes) in plant growth promotor.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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