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Maize yield and its attributes influenced by biofertilizers and presoaking treatment of nitrate salts

■ S.P. TIWARI, S.P. MISHRA[1] AND ARTI GUHEY[2]

AUTHORS' INFO

Associated Co-author :

[1]Department of Crop Sciences, Mahatama Gandhi Chitrakoot Gramoday Vishwavidyalaya, CHITRAKOOT (M.P.) INDIA

[2]Department of Crop Physiology, Indira Gandhi Krishi Vishwavidyalaya, RAIPUR (C.G.) INDIA
Email : arti_guhey@rediffmail.com

Author for correspondence :
S.P. TIWARI
Department of Crop Physiology, Indira Gandhi Krishi Vishwavidyalaya, RAIPUR (C.G.) INDIA
Email : shashiprakash30@gmail.com

ABSTRACT : The present study was carried out to examine the grain yield and attributes of maize (*Zea mays*) influenced by bio- fertilizers and presoaking treatment of nitrate salts during *Kharif* 2008-09 and 2009-10 at precision farming development centre I.G.K.V. Raipur (C.G.). Experiment was conducted in Split Plot Design comprising of three varieties (deshi, hybrid and composite) as a main plot, while biofertilizers and nitrate salts combination in sub plot treatment. Observations were taken the number of cob per plant, cob length, cob diameter, number of seed per cob, seed weight, grain yied, stover yield and harvest index. It is clearly indicated that superiority in treatment 9 (50% fertilizer + *Azospirillum* + Calcium nitrate salts) exhibited maximum grain yield, stover yield and harvest index.

Key Words : *Azospirillum*, Biofertilizers, Nitrate salts, Yield attributes, Harvest index

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Maize is one of the most important cereal crops in the world agricultural economy both as food for man and feed for animals.There is no cereal on the earth which has so immense potentiality and that is why it is called queen of cereals. The soil-plant-climatic management complex are often ignored while selecting hybrid seeds of maize .Appropriate hybrids are those which allow weather technology and management to be fully expressed in high yield. Maize is a highly income generative and cost effective crop so management orientation is essential to fetch the maximum profit. Therefore, efforts were made to find suitable composite or hybrid varieties of maize along with proper fertilizers and nitrate salt combination for agro-ecological farming situation of this region.

Among the coarse cereals, maize has the highest average national productivity of 2.18-2.35 t ha^{-1} . At present, the area covered by maize crop in India is about 8.0-8.2 m ha (Anonymous,2009). Maize potential has to be seen in terms of its productivity in countries like U.S.A. (8 t ha^{-1}) and China (5.6 t ha^{-1}). Giving allowance to different growing situations in India, it could, however, be safe to expect national average yields to reach around 3 t ha^{-1}. Maize does possess tremendous potential in terms of feeds for dairy, poultry and piggery agro-industries. Diversified uses of maize for starch industry, corn oil production, baby corns, popcorns etc., would further provide the much-needed impetus to the growth of maize. No other cereal can be used in as many ways as maize. Virtually every part of the maize plant has economic value, including the grain, the leaves, the stalks, the tassels and in some cases, even the roots.

The high efficiency of nitrogen fixation combined with low energy requirements easy establishment on plant roots and tolerance of high soil temperature exhibited by *Azotobactor* and *Azospirillum* seem to make them ideally suited as microbial inoculants for cereal crops under tropical condition results of the preliminary field trials on crops like rice, wheat, barley, sorghum, maize, millets are quite encouraging. The higher yield potentiality of maize cannot be manifested upto the breme due to several biotic and abiotic factors among which poor nutritional management is the prime one. The soaking of seed with various nitrate salts prior to sowing of maize, mustards and okra has shown a positive impact on their germination as well as on vegetative growth .

RESEARCH PROCEDURE

The experiment was conducted in research field of precision farming development centre, Indira Gandhi Krishi Vishwavidyalya, Raipur (C.G.) during *Kharif* season of 2009-10. Experiment was comprised of three levels of varieties *viz*., hybrid, composite and deshi. The design adopted for experiment was spilt-plot with three replication. Bold and healthy seeds of maize (hybrid, composite and deshi) were surface sterilized with 0.1 per cent of $HgCl_2$ for five minutes. These were washed thoroughly and soaked either in distilled water or in solution of different nitrate salts containing 15 mM of nitrate salt *i.e.* $Mg(NO_3)_2$ and $Ca(NO_3)_2$, in petridishes on filter paper for 24h. Seed of maize were treated with N_2 fixing biofertilizer (*Azospirillum*) disolving the seed with 20 g of biofertilizer (*Azospirillum*) and 10ml of water and powdered over one kg of seeds. The seeds were mixed with hand to get proper coating. There after the seed were dried and treated seed were sown immediately in the field at spacing 60x 25 cm using a seed rate of 25kg ha. Nitrogen, phosphorus and potash were applied in the form of urea (46%N), Single super phosphate (16%P_2O_5) and muriate of potash (60%K_2O). Nitrogen was applied in two splits *i.e.* ½ at basal, ½ each at 30 DAS, whereas, full doses of P_2O_5 and K_2O in each treatment were applied as basal at the time of sowing. Observations were recorded on five randomly selected plants in each plot number of cob per plant, cob length, cob diameter ,number of seed per cob, seed weight, grain yied, stover yield and harvest index. Seed yield was also analysed at maturity. Statistical analysis was done as per the procedure given by Gomez and Gomez (1984).

RESEARCH ANALYSIS AND REASONING

The results related to number of row of cob has been presented in Table 1. All the varieties and treatments differed significantly in both the year as well as in pooled mean. The interaction effect was not found significant in both year. As varieties are concerned the maximum number of rows per cob was noticed in variety V_1 (hybrid)followed by V_2 (composite) while the minimum number of row of cobs was recorded in (deshi). As treatments was concerned maximum number of row of cobs was recorded with T_9 (50% fertilizer + *Azospirillum* + calcium nitrate salts) followed by T_{10} (50% fertilizer + *Azospirillum* + magnesium nitrate salts) while minimum number of row of cob was observed in control treatment. During the second year maximum number of rows of cob was noticed under superiority of V_1 (hybrid) and minimum number of row of cob was observed in V_3 (deshi). Among the treatment T_9 (50% fertilizer + *Azospirillum* + calcium nitrate salts) resulted the maximum among row of cob while minimum number of row cob under T_1 (control). Thorat and Ramteke (1988) also reported similar results. The results of cob length and cob diameter has been presented in Table 1. All the varieties and treatments differed significantly in both the year as well as in pooled mean. The interaction effect was not found significant in both the years. Among the varieties concerned maximum cob diameter was noticed in variety V_1 (hybrid) followed by V_2 (composite) and while the minimum cob diameter was recorded in V_3 (deshi). As treatments was concerned maximum cob diameter was recorded with T_9 (50% fertilizer + *Azospirillum* + calcium nitrate salts) followed by T_{10} (50% fertilizer + *Azospirillum* +

Table 1: Effect of biofertilizers and nitrate salts on number of row /cob, cob length and cob diameter of maize

Variety \	Number of row /cob			Cob length			Cob diameter		
Treatment	2009	2010	Pooled	2009	2010	Pooled	2009	2010	Pooled
V_1	13.0	13.0	13.0	16.30	17.32	16.81	12.71	12.73	12.72
V_2	12.87	12.79	12.83	16.00	17.25	16.62	11.18	12.67	11.92
V_3	11.61	11.96	11.78	15.30	15.91	15.60	10.36	11.95	11.15
S.E.±	0.12	0.17	0.14	0.2374	0.20	0.21	0.1866	0.12	0.13
C.D. (P=0.05)	0.47	0.65	0.43	0.9319	0.78	0.68	0.7325	0.46	0.38
T_1	11.51	11.83	11.67	14.84	14.51	14.67	10.69	11.89	11.29
T_2	12.55	12.15	12.35	14.79	15.06	14.92	11.26	12.39	11.82
T_3	12.41	12.34	12.37	16.96	17.17	17.06	10.42	12.42	11.42
T_4	12.27	12.43	12.35	16.63	17.19	16.91	11.36	12.17	11.76
T_5	12.93	12.81	12.87	16.08	17.22	16.65	11.38	12.59	11.98
T_6	12.19	12.64	12.40	15.67	15.96	15.81	11.25	12.27	11.76
T_7	12.20	12.54	12.37	16.84	17.16	17.00	11.59	12.43	12.01
T_8	12.71	12.50	12.60	17.27	17.05	17.16	11.94	12.72	12.33
T_9	13.62	13.90	13.76	19.07	19.16	19.11	12.66	13.39	13.02
T_{10}	12.52	12.68	12.60	17.85	17.78	17.81	11.66	12.27	11.96
S.E.±	0.07	0.09	0.08	0.2664	0.11	0.12	0.3707	0.09	0.08
C.D. (P=0.05)	0.10	0.13	0.17	0.7549	0.15	0.35	1.0505	0.12	0.23

magnesium nitrate salts) while minimum cob diameter was observed in control treatment. In second year maximum cob diameter was found in variety V_1 (hybrid) while minimum cob diameter was observed in V_3 (deshi). Among the treatments maximum cob diameter was observed with T_9 (50% fertilizer + *Azospirillum* + calcium nitrate salts) while minimum was noticed under control. Similar results were also observed by Krishnotar *et al.* (2009). Sufficient supply of nitrogen favoured the rate of photosynthesis by increasing leaf area and crop growth, which ultimately produced more photosynthetic materials in the form of carbohydrate, similar results were also observed by Saikia *et al.* (2003).

The results related to cob plant^{-1} has been presented in Table 2. All the varieties and treatments differed significantly in both the years as well as in pooled mean. The interaction effect was not found significant in both the years. As varieties are concerned maximum number of cob plant^{-1} were noticed in the V_1 (hybrid). Among the treatments maximum number of cob plant^{-1} was recorded in T_9 (50% fertilizer + *Azospirillum* + calcium nitrate salts) followed by T_{10} (50% fertilizer + *Azospirillum* + magnesium nitrate salts) while minimum number of cob plant^{-1} was observed under control. The results of number of cob plant^{-1} has been presented in Table 2. As varieties was concerned maximum number of seed cob^{-1} were noticed in the V_1 (hybrid). Among the treatments maximum number of seed cob^{-1} was recorded in T_9 (50% fertilizer + *Azospirillum* + calcium nitrate salts) followed by T_{10} (50% fertilizer + *Azospirillum* + magnesium nitrate salts) while minimum number of seed cob^{-1} was observed under control. During second year maximum number of seed cob^{-1} was recorded under superiority of V_1 (hybrid) while minimum number of seed cob^{-1} was noticed in V_3 (deshi). Among the treatments maximum number of seed cob^{-1} was noticed under T_9 (50% fertilizer + *Azospirillum* + magnesium nitrate salts) and minimum was observed under the control Similar results were documented by Krishnotar *et al.* (2009) and Saikia *et al.* (2003).

The results related to test seed weight has been presented in Table 3. All the varieties and treatments differed significantly in both the year as well as in pooled mean. The interaction effect was not found significant in both the year. Among the varieties concerned that maximum test seed weight was noticed in variety, V_1 (hybrid) followed by V_2 (composite) while the minimum test seed weight recorded in V_3 (deshi). As treatment was concerned maximum test seed weight was recorded with T_9 (50% fertilizer + *Azospirillum* + calcium nitrate salts) followed by T_{10} (50% fertilizer + *Azospirillum* + magnesium nitrate salts) while minimum test seed weight was noticed under control. During the second year maximum test seed weight was recorded under V_1 (hybrid) while minimum was noticed under V_3 (deshi) and Among the treatments maximum test seed weight was notice in T_9 (50% fertilizer + *Azospirillum* + Calcium nitrate salts) and minimum weight was observed in control treatment similar results reported by Pandey and Bose (2006). The results related to thousand seed weight has been presented in Table 3. All the varieties and treatments varied significantly in both the years as well as in pooled mean. The interaction effect was not found significant in both the years. Among the varieties concerned thousand seed weight was found highest in variety, V_1 (hybrid) followed by V_2 (composite) while the minimum seed

Table 2 : Effect of bio fertilizers and nitrate salts on number of cob/ plant and number of seed/ cob in maize

Variety \ Treatment	Cob per plant			Seed per cob		
	2009	2010	Pooled	2009	2010	Pooled
V_1	2.38	2.39	2.38	378.00	366.93	372.46
V_2	2.34	2.29	2.31	375.00	365.07	370.35
V_3	1.66	2.15	1.90	344.00	339.73	341.86
S.E.±	0.04	0.04	0.03	3.28	3.94	3.45
C.D. (P=0.05)	0.17	0.15	0.16	12.86	15.46	16.25
T_1	1.79	1.60	1.69	264.12	268.56	266.38
T_2	2.27	1.93	2.10	303.67	285.56	294.61
T_3	2.10	1.91	2.00	349.11	252.78	300.94
T_4	1.92	2.29	2.10	344.42	323.33	333.87
T_5	1.88	2.67	2.27	374.73	380.00	377.36
T_6	2.06	2.38	2.22	352.51	335.56	344.03
T_7	2.24	2.48	2.36	359.32	335.44	347.38
T_8	2.23	2.15	2.19	408.00	404.22	406.11
T_9	2.61	3.04	2.82	454.40	478.11	466.25
T_{10}	2.20	2.34	2.27	447.50	408.89	428.39
S.E.±	0.05	0.05	0.06	3.07	0.04	0.05
C.D. (P=0.05)	0.07	0.07	0.17	12.03	0.16	0.17

was recorded variety in V_3 (deshi). As treatment was concerned highest value of thousand seed weight was recorded in T_9 (50% fertilizer + *Azospirillum* +calcium nitrate salts) followed by T_{10} (50% fertilizer + *Azospirillum* + magnesium nitrate salts) while minimum value was noticed in control treatment. During second year maximum thousand seed weight was noticed under in variety V_1 (hybrid) and minimum value was found in V_3 (deshi). Among the treatment maximum value of thousand seed weight was observed in T_9 (50% fertilizer + *Azospirillum* + calcium nitrate salts) minimum value was obtained in control. Similar results were documented by Krishnotar *et al.* (2009) and Saikia *et al.* (2003).

The results related to grain yield is presented in Table 4. All the varieties and treatments differed significantly in both the years as well as in pooled mean value. The interaction effect was found not significant in both the years. Among the

Table 3 : Effect of bio-fertilizers and nitrate salts on test seed weight and thousand seed weight in maize

Variety \	Test seed weight			Thousand seed weight		
Treatment	2009	2010	pooled	2009	2010	pooled
V_1	28.37	27.48	27.92	283.88	274.8	279.34
V_2	27.78	25.60	26.69	278.0	256.0	267.00
V_3	26.01	24.82	25.41	260.17	248.2	254.18
S.E.±	0.10	0.18	0.16	1.02	1.79	1.85
C.D. (P=0.05)	0.38	0.70	00.49	3.99	7.03	5.57
T_1	26.94	22.76	24.85	269.4	227.6	248.50
T_2	27.54	24.26	25.90	275.4	242.6	259.00
T_3	26.73	25.90	26.31	267.3	259.0	263.15
T_4	26.52	26.68	26.60	265.2	266.8	266.00
T_5	26.74	27.62	27.18	267.4	276.2	271.80
T_6	27.29	25.94	26.61	272.9	259.4	266.15
T_7	27.05	25.45	26.25	270.5	254.5	262.50
T_8	27.16	25.34	26.25	271.6	253.4	262.50
T_9	29.49	28.96	29.22	294.9	289.6	292.25
T_{10}	28.41	27.78	28.09	284.1	277.8	280.95
S.E.±	0.09	0.10	0.12	0.88	0.96	0.94
C.D. (P=0.05)	0.13	0.14	0.37	1.25	1.35	2.82

Table 4 : Effect of biofertilizers and nitrate salts on grain yield, stover yield and HI of maize

Variety \	Grain yield			Stover yield			Harvest index		
Treatment	2009	2010	Pooled	2009	2010	Pooled	2009	2010	Pooled
V_1	5.01	4.53	4.81	11.20	11.11	11.15	32.29	31.85	32.07
V_2	4.07	3.55	3.81	10.00	10.18	10.09	31.11	31.00	31.05
V_3	3.02	3.25	3.13	7.01	7.11	7.06	30.29	30.03	30.16
S.E.±	0.07	0.09	0.08	0.03	0.11	0.10	0.20	0.05	0.07
C.D. (P=0.05)	0.29	0.35	0.27	0.14	0.45	0.30	0.80	0.21	0.23
T_1	2.73	2.95	2.84	6.37	7.34	6.85	27.99	26.86	27.42
T_2	3.53	3.17	3.35	8.12	8.53	8.32	30.46	30.82	30.64
T_3	3.67	3.41	3.54	8.74	8.97	8.85	31.39	31.29	31.34
T_4	3.67	3.43	3.55	8.75	8.96	8.85	32.04	31.17	31.60
T_5	4.02	4.19	4.10	9.82	10.32	10.07	31.45	31.83	31.64
T_6	4.05	3.55	3.80	9.97	9.20	9.58	31.21	31.44	31.32
T_7	4.05	3.71	3.88	9.63	9.36	9.49	31.46	31.14	31.30
T_8	4.39	4.14	3.76	10.52	10.07	10.29	32.09	31.23	31.66
T_9	5.38	4.72	5.05	11.45	11.71	11.58	33.09	32.34	32.71
T_{10}	4.84	4.50	4.67	10.65	10.26	10.45	31.12	31.46	31.29
S.E.±	0.05	0.11	0.09	0.06	0.10	0.11	0.14	0.11	0.10
C.D. (P=0.05)	0.07	0.16	0.26	0.08	0.14	0.32	0.20	0.15	0.31

varieties concerned the maximum grain yield, was obtained in variety V_1 (hybrid) followed by V_2 (composite) while the minimum grain yeild was recorded in V_3 (deshi). As treatments was concerned the maximum grain yield, was recorded with T_9 (50% fertilizer + *Azospirillum* + calcium nitrate salts) followed by T_{10} (50% fertilizer + *Azospirillum* + magnesium nitrate salts) while minimum grain yield was recorded control treatment. During second year maximum grain yield, was noticed under in variety of V_1 (hybrid)while minimum grain yield was found in V_3 (deshi). Among the treatment T_9 produced maximum grain yield while T_9 (50% fertilizer + *Azospirillum* + calcium nitrate salts) minimum was found in control treatment Saikia *et al.* (2003) reported significantly higher grain yield in maize crop on such spectacular response of *Azospirillum* treatment on growth characters, yield attributes and yield reported which might be due to change in microbial population of rhizosphere and production of plant growth hormones apart from supplying nitrogen as reported by Brown (1974) and Jirali *et al.* (2007) also reported that micronutrients was very much responsible for determination of grain yield. The results of stover yield is presented in Table 4. All the varieties and treatments differed significantly difference stages in both the years as well as in pooled mean. Interaction effect was found significant in both the years. Among the varieties the maximum stover yield was exhibited in the variety V_1 (hybrid) followed by V_2 (composite) while the minimum stover yield was recorded in V_3 (deshi). As treatment was concerned maximum stover yield was recorded in T_9 (50% fertilizer + *Azospirillum* + calcium nitrate salts) followed by T_{10} (50% fertilizer + *Azospirillum* + magnesium nitrate salts) while minimum stover yield was observed in control. During second year maximum stover yield was noticed in V_1 (hybrid) and minimum was found in V_3 (deshi). Among the treatment maximum stover yield was observed, T_9 (50% fertilizer + *Azospirillum* + calcium nitrate salts) while minimum stover yield was noticed under control treatment similar results were also obtained by Saikia *et al.* (2003) The results related to harvest index is presented in Table 4. All the varieties and treatments differed significantly in both the year as well as in pooled mean. The interaction effect was found non-significant in both the years. Among the varieties concerned that maximum harvest index was recorded under the variety V_1 (hybrid) followed by V_2 (composite) while the minimum harvest index was found in V_3 (deshi). As treatment are maximum harvest index was recorded in T_9 (50% fertilizer + Azospirillum + Calcium nitrate salts) at all the stages of plant growth followed by T_{10} (50% fertilizer + *Azospirillum* + magnesium nitrate salts) while minimum yield, harvest index was observed under control. In second year maximum harvest index was noticed in variety, V_1 (hybrid) while minimum harvest index was found in V_3 (deshi). Among the treatment maximum harvest index was observed, T_9 (50% fertilizer + *Azospirillum* + calcium nitrate salts) and minimum harvest index was noted under control. In second year maximum harvest index was noticed in variety V_1 (hybrid) while minimum harvest index was found in V_3 (deshi). Among the treatment maximum harvest index was observed with treatment, T_9 (50% fertilizer + *Azospirillum* + calcium nitrate salts) while minimum harvest index was noticed under control treatment. The effect of nitrates in the form of seed soaking/ seed hardening treatment was found to improved the yield in mustard, wheat and maize as reported by Pandey and Bose (2006), Anaytullah (2007) and Krishnotar *et al.* (2009). Azospirillum can also be attributed to increase in number of lateral roots and root hair formation (Jain and Patriquin, 1985). Similar results was found by Chela *et al.* (993).

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