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Research Article

PERFORMANCE OF BIO-PRODUCT TORQUE ON GROWTH AND PRODUCTIVITY OF CORN

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Abstract- Maize is the third most important cereal crop due to its importance in food, feed, fuel, specially corn, starch etc and acquires an important place in the food grain basket of our country. There is a need of better production technology to reach higher productivity to meet the projected demand in India. LCO (lipo-chitooligosaccharide) Promoter Technology present in Torque is a unique molecule enhances a plant's nutritional capabilities that ultimately leads to higher yields and better returns at the end of the season when present at the time of planting independently of variety, soil and environmental conditions. So, a field experiment was conducted at Central Research Farm, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal, India during *Rabi* seasons of 2012-14 to study the effect of bio-product Torque (LCO Promoter Technology) as seed treatment on growth and productivity of corn. The experiment was laid out in randomized block design with seven treatments combining Torque RTA @ 4 ml/2 kg seed, 8 ml/2 kg seed and 12 ml/2 kg seed and time of treatment @15 days before sowing and at the time of sowing, replicated thrice. Results revealed that treated plot performed better than untreated plot. Seed treatment before 15 days of sowing with high dose performed better than those sown immediately after treatment. The yield parameters like cob length, number of cobs plot^{-1} and cob yield were reflected better with Torque RTA @ 12 ml/2 kg seed treated at 15 days before sowing which ultimately resulted the highest grain yield of 6.83 t ha^{-1}.

Keywords- Maize, LCO, Torque, Root growth, Chlorophyll.

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Introduction

Plants have various symbiotic associations with beneficial symbiotic microorganisms like rhizobial bacteria and mycorrhizal fungi, which make nutrients available to the plants. Lipo-chitooligosaccharides (LCOs), the key molecule of the product Torque are the important signal molecules secreted by these microorganisms to initiate symbiotic association with plants. Recently, LCOs were identified as the Myc factors produced by arbuscular mycorrhizal fungi, which colonize the roots of most plants to improve plant nutrition and water uptake [1]. However, a number of reports from experiments have recommended a vast role of LCOs as a plant growth regulator influencing plant biomass production, shoot and root growth, lateral root branching, embryogenesis and seed germination [1-5]. LCO treatment of plants also has an important role to protect against the detrimental effects of abiotic and biotic stresses [6-8]. LCO can induce gene expression in non-legume plants.

Maize is the third most important cereal crop, with highest per day productivity, due to its importance in food, feed, fuel, specialty corn, starch etc and acquires an important place in the food grain basket of our country. The current percentage consumption pattern for maize in India includes poultry feed (52) human food (24), animal feed (11) and industrial use (22+). Some estimates indicate that India have a projected demand of 55 million tons of maize into all these aforesaid requirements by 2030 [9]. The influence of LCO addition on seedling growth of maize (*Zea mays*), a major non-legume crop were examined. It was observed from the results that LCO treatment increased root growth and LCO addition had a significant impact on plant gene expression. Some genes involved in root growth promotion were significantly regulated by LCO treatment. The result suggested that LCO promotes maize root growth by regulation of specific gene expression, clearly expanding the function of this molecule beyond a symbiotic role [10].

The lateral root lengths of maize seedlings, treated with LCO were significantly longer than untreated controls but there was no difference in the number of lateral roots. However, there were no notable effects of LCO treatment on fresh weight, mesocotyl length, and length and number of nodal roots and seminal roots [10].

Reports propose that LCOs can have vast ranging effects on legumes and non-legumes, as well as non-mycorrhizal plants. The current reports reveal that LCO enhances root growth of maize and *Setaria* seedlings, which may be a general response at least among the grass family. So, the objectives of the experiment were to evaluate the effect of LCO containing product Torque as seed treatment on growth and yield parameters of Maize as well as chlorophyll content.

Methodology

Study Area

The experiment was conducted at the Central Research Farm, Gayeshpur, New Alluvial Zone (NAZ), under Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal, India during *Rabi* season of 2012-13 and 2013-14 to evaluate the performance of bio-product Torque as seed treatment on growth and productivity of Maize (var. Shrestha). The topography of land is medium land and the soil was sandy clay loam in texture having a pH of 6.9. Soil of this zone is mostly fertile, deep and almost neutral in reaction developed from recent alluvium of the river Ganges.

Treatment details

The experiment was laid out in randomized block design with seven treatments as

follows and replicated thrice.

Sl. No.	Doses of the product (seed treatment)	Time of application
T_1	Torque RTA 4 ml/2 kg seed	Sowing 15 days after seed treatment
T_2	Torque RTA 8 ml/2 kg seed	Sowing 15 days after seed treatment
T_3	Torque RTA 12 ml/2 kg seed	Sowing 15 days after seed treatment
T_4	Torque RTA 4 ml/2 kg seed	Sowing immediately after seed treatment
T_5	Torque RTA 8 ml/2 kg seed	Sowing immediately after seed treatment
T_6	Torque RTA 12 ml/2 kg seed	Sowing immediately after seed treatment
T_7	Untreated control	

The general package and practice was followed except the seed treatment was done according to the respective treatments. Observations on plant height, plant population, root length, dry weight of shoot and root, cob length, number of cobs per plot, cob yield, grain yield and chlorophyll content were recorded time to time.

Chlorophyll estimation

Leaf tissues of maize (100 mg) were taken in a test tube containing 10 ml of 80% buffered acetone (80 ml of acetone added with 20 ml of 2.5 mM sodium phosphate buffer and made up to 100 ml, pH 7.8) and the test tube were placed under refrigeration. After incubation, the extract liquid was filtered through glass wool to remove leaf pieces and transferred to another graduated tube. After checking the turbidity of extract at 750 nm, the chlorophyll content was analysed in a dual beam recording UV visible spectrophotometer [11].

Statistical Analysis

All statistical analyses were carried out by using SPSS Statistics 17.0 and analysis of variance (ANOVA) was employed to examine statistical significance of differences. Significance of differences among variables were tested at $p<0.05$ level of significance.

Results

Growth parameters

It has been observed that treated plot with Torque performed with better results than in untreated control plot both at 30 DAS, 60 DAS and at harvest. There was no regular trend of observation in 30 DAS. In 60 DAS, significantly ($P < 0.05$) maximum root length was recorded in T_3 (15.02 cm) but statistically at par with all the other treated plots. Root dry weight/plant of treated plants at 30 DAS was significantly different from the untreated plants but no significant difference was recorded between the different doses and time of application [Table-1]. But at 60 DAS and at harvest, the maximum root dry weight was recorded with T_2 i.e. seed treatment with 8ml /2Kg seed and sown 15 days after seed treatment which was statistically ($P < 0.05$) at par with T_3 (12ml/2kg seed & sown at 15 days after seed treatment). Root length at harvest also followed the same trend. Maximum dry weight of plant (27.00 g) and plant height (84.67 cm) were recorded in T_4 and T_5 respectively at 60 DAS. The maximum plant height at harvest was recorded with T6 and T4 followed by T3 with no significant difference. As the doses increase, the growth parameters also increases irrespective of 15 days after and immediately treated seed sown, but increment was better when seed sown after 15 days of treatment.

Table-1 *Effect of different doses of Torque on growth parameters of maize at 30 days and 60 days after sowing (Pooled)*

Treatments	Root length (cm)		Root dry weight/ plant (g)		Dry weight/ plant (g)		Plant height (cm)	
	30DAS	60DAS	30DAS	60DAS	30DAS	60DAS	30DAS	60DAS
T_1	8.72	14.17	0.85	2.70	2.14	21.87	23.91	77.74
T_2	8.63	14.12	0.84	3.75	2.11	21.40	24.08	73.78
T_3	8.52	15.02	0.87	3.18	2.12	26.88	27.23	79.33
T_4	8.34	14.62	0.86	3.00	2.22	27.00	25.74	84.56
T_5	8.74	14.28	0.85	2.80	2.25	25.93	25.22	84.67
T_6	8.48	14.65	0.85	2.40	2.12	26.73	23.49	83.55
T_7	7.09	12.60	0.77	2.45	2.10	20.80	21.50	70.33
S.Em(±)	0.29	0.41	0.01	0.24	0.08	1.28	0.59	3.20
CD (P=0.05)	0.90	1.26	0.04	0.74	NS	3.94	1.82	9.85

Chlorophyll content

In general, chlorophyll content was recorded maximum at 60 DAS due to its active growing stages than the earlier date of observations. However, total chlorophyll content reflected maximum with the treatment T_2 (2.718 mg/g) at 30 DAS and T_3 (3.500 mg/g) at 60 DAS respectively [Table-2]. The entire treated plot showed more chlorophyll content than untreated plot. From the results, it has been found that seed treatment before 15 days of sowing with high dose performed better than those sown immediately after seed treatment.

Table-2 *Effect of different doses of Torque on chlorophyll content (mg/g fresh tissue) of corn at 30 DAS and 60 DAS (Pooled)*

Sl. No.	Entries	30 DAS			60 DAS		
		a	b	Total	a	b	Total
T_1	4ml/2kg seed- sowing 15 days after seed treatment	2.022	0.715	2.602	2.340	0.657	2.996
T_2	8ml/2kg seed- sowing 15 days after seed treatment	1.909	0.810	2.718	2.239	0.602	2.841
T_3	12ml/2kg seed- sowing 15 days after seed treatment	2.004	0.575	2.578	2.712	0.789	3.500
T_4	4ml/2kg seed- sowing immediately after seed treatment	2.047	0.554	2.600	2.288	0.630	2.918
T_5	8ml/2kg seed- sowing immediately after seed treatment	2.058	0.561	2.618	2.260	0.629	2.889
T_6	12ml/2kg seed- sowing immediately after seed treatment	2.105	0.589	2.694	2.388	0.671	3.058
T_7	Untreated	1.888	0.413	2.434	2.195	0.629	2.823

Yield parameters

The maximum cob length (17.03cm), number of cobs plot^{-1} and cob yield were obtained when seeds were treated with 12ml/2kg seed and sown 15 days after seed treatment (T_3) which ultimately gave the highest grain yield of 6.83 t ha^{-1} [Table-3], though all the treated plots were statistically at par but significantly ($P < 0.05$) different from the untreated plot. In case of grain yield, 8ml/2kg seed and 12ml/2kg seed resulted statistically at par but seed treatment @15 days before sowing resulted in better yield than seed treatment at the time of sowing.

Discussion

LCO as Myc factor released by arbuscular mycorrhizal fungi also regulates both plant growth, regulating phosphate transport related genes, as well as arbuscule formation [1, 12]. That might be the reason of better results in plant growth and development in all the treated plots. Again, the report suggests that LCOs function

Table-3 *Effect of different doses of Torque on growth and yield parameters of corn at harvest (Pooled)*

Treatments	Plant height (cm)	Root length (cm)	Root dry weight/ plant (g)	Cob length (cm)	No. of cobs plot^{-1}	Cob yield (kg plot^{-1})	Grain yield (t/ha)
T_1	216.23	25.15	20.21	16.82	122.00	15.29	5.68
T_2	237.22	26.18	32.17	16.26	124.00	15.58	6.35
T_3	239.18	21.77	27.61	17.03	128.00	16.71	6.83
T_4	240.22	24.52	23.88	15.92	120.00	15.91	5.86
T_5	234.89	25.35	20.56	16.46	116.00	15.20	6.29
T_6	243.11	25.65	29.20	15.23	128.00	15.81	6.44
T_7	219.11	20.50	22.69	13.20	108.00	13.49	5.02
S.Em(±)	4.30	1.65	2.77	0.87	4.16	0.57	0.26
CD (P=0.05)	13.24	5.07	8.55	2.69	12.83	1.75	0.81

as a regulator of root growth and development to promote mycorrhizal infection. LCO promotes the elongation of lateral roots [10]. In this experiment, root length and root dry weight also increased when seeds are treated with Torque. Mycorrizal infection helps in improving the expansion of roots and ultimately the root dry weight and length.

Significant increase in chlorophyll content when seeds were treated with LCO was also reported [13].

Torque with LCO molecules enable earlier mycorrhizal colonization of the plant and can directly impact maize root growth [10], leading to enhanced nutrient availability and/or improved uptake through the roots. Enhanced nutrient availability can lead to increased yield potential.

Conclusion

From the results, it has been concluded that LCO containing bio-product Torque has a definite role over root growth, plant growth and development, chlorophyll content and ultimately productivity. Higher doses resulted better irrespective of the time of treatment. However, higher doses of Torque @ 12 ml/2 kg of seed sown after 15 days of seed treatment may be recommended.

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Author contribution

First and second author: Designed the experiment, analyzed the data, interpretation of results and preparation of manuscripts. Third author: Performed the experiment. Fourth author: Review of literature and preparation of manuscripts.

Conflict of Interest: None declared

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