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COMPARISON BETWEEN THE BASAL AND FOLIAR APPLICATION OF BORON AND PHYSIO-CHEMICAL PROPERTIES OF SOILINMAIZE

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Abstract– An experiment was conducted during *Kharif* season (July 2021 – Nov. 2021) which revealed after application of different levels NPK and boron applied through foliar application increases growth, yield of maize whereas through basal application the soil physical and chemical properties found to be best, in which maximum physical properties such as bulk density particle density % pore space water holding capacity varies from depth 0-15 cm to 15-30 cm was 1.305 Mg m^{-3} to 1.310 Mg m^{-3}, 2.546 Mg m^{-3} to 2.548 Mg m^{-3} at 15-30 cm, 46.87 % at 0-15 cm and 44.50 % at, 39.62 % at 0-15 cm and 37.95 % at 15-30 cm, pH 6.90 at 0-15 cm and 6.92 at 15-30 cm, EC 0.278 dSm^{-1} at 0-15 cm and 0.281 dSm^{-1} at 15-30 cm, organic carbon 0.561 % at 0-15 cm and at 0.550 % at 15-30 cm, available nitrogen 332.45 kg ha^{-1} at 0-15 cm and 325.22 kg ha^{-1} at 15 -30 cm, available phosphorus 35.75 kg ha^{-1} at 0-15 cm and 32.30 kg ha^{-1} at 15 -30 cm, available potassium 221.46 kg ha^{-1} at 0 -15 cm and 219.54 kg ha^{-1} at 15-30 cm, available boron 0.85 mg kg^{-1} at 0-15 cm and 0.73 mg kg^{-1} at 15-30 cm with cost benefit ratio is 1: 1.83 best from T_1 [@ 0% RDF + 0% Boron].

INTRODUCTION

Maize (*Zea mays* L.) is a cereal crop, and it is called as "Queen of cereals" and "non-tillering plant". Maize is one of the three major World food crops, is recognized as the "golden food" because of its high grain yield and nutrition value and plays a very important role in the daily calorie intake of humans. Maize is the third most important crop in India after rice and wheat. In the World, India's ranks 5th in acreage and 8th in production of maize. Globally, total area of maize was 186.86 m ha, production 1078.56 Mt and in India area under maize cultivation is about 9.63 m ha, production 25.90 M t in 2016-17 (Zhong *et al*., 2014).

In Uttar Pradesh, soil is 12% deficient in boron as it plays role in maize by stimulation of root and shoot development, early tassel and silk formation, movement of sugars from leaves to ears, pollen germination capacity, seed formation, storage of assimilates, better water use efficiency and drought tolerance. Boron can be used as soil and foliar applications on growing crop. Foliar application of Boron is believed to retain significant carbohydrate phloem mobility to flowering meristematic cell from either senescing leaves/bark. Thus, foliar spray of boron is not only a source to apply boron at a particular growth stage but also permits a rapidly acting action to mitigate the problem soon after the deficiency diagnosis (Gazala *et al*., 2016).

MATERIALS AND METHODS

The present study was carried out at the Soil Science & Agricultural Chemistry Research Farm, Sam Higginbottom University of Agriculture Technology and Sciences Prayagraj during Kharif season 2021, Variety sown was GA-85 for the experiment which lead in randomized block design with three levels of NPK (0, 50, 100 kg ha^{-1}), RDF and boron as basal

dose and boron as foliar spray. After harvesting the soil samples were taken upto 0-15 and 15-30 cm depth for the estimation of Physical properties include bulk density, partical density, pore space, and water holding capacity was done by 100 ml measuring cylinder and for Chemical properties include pH by digital pH meter, EC by digital EC meter, Organic carbon by wet oxidation method, available nitrogen by alkaline permanganate method, available phosphorus by photoelectric calorimetric method, available potassium by flame photometer method and available sulphur by turbiditmetric method.

RESULTS AND DISCUSSION

Physical properties of soil

The result of data depicted in Table 1showed that maximum bulk density (Mg m^{-3}) of soil were found in treatment T_9 which was at 0-15 cm (1.305 Mgm^{-3}) and at 15-30 cm (1.310Mgm^{-3}) followed by T_8 at 0-15 cm (1.303Mgm^{-3}) and at 15-30 cm (1.307Mgm^{-3}) while the minimum values of the result were found in treatment T_1 which was at 0-15 cm (1.286 Mgm^{-3}) and at 15-30 cm (1.289Mgm^{-3}) respectively. The maximum particle density (Mg m^{-3}) of soil were found in the treatment T_9[@ 100% RDF+ 5 kg Boron ha^{-1} (basal dose)] which was at 0-15 cm (2.526 Mgm^{-3}) and at 15-30 cm (2.548Mgm^{-3}) followed by T_8[@ 100% RDF+ 0.5% B (foliar spray)] at 0-15 cm (2.524 Mgm^{-3}) and at 15-30 cm (2.546 Mgm^{-3}) while the minimum values of the result were found in treatment T_1 which was at 0-15 cm (2.520 Mgm^{-3}) and at 15-30 cm (2.528Mgm^{-3}) respectively. The result maximum % pore space of soil was found in the treatment T_9 [@ 100% RDF+ 5 kg Boron ha^{-1} (basal dose)] which was at 0-15 cm (42.87%) and at 15-30 cm (37.50%) followed byT_8[@ 100% RDF+ 0.5% B (foliar spray)] at 0-15 cm (41.49%)and at 15-30 cm (36.86%) while the minimum values of the result were found in treatment T_1[@ 0% RDF + 0% Boron] which was at 0-15 cm (38.32%) and at 15-30 cm (32.72%) respectively. Similar results were found by Kannan *et al*., 2013; Kumar *et al*., 2015 and Jayprakash *et al.,* 2005.

The maximum Water holding capacity (%) of soil was found in treatment T_9[@ 100% RDF+ 5 kg Boron ha^{-1} (basal dose)] which was at 0-15 cm (34.62%) and at 15-30 cm (36.95 %) followed by T_8[@ 100% RDF+ 0.5% B (foliar spray)] at 0-15 cm (31.42%)and at 15-30 cm (35.87%) while the minimum values of the result were found in treatment T_1[@ 0% RDF + 0% Boron] which was at 0-15 cm (30.57%)and at 15-30 cm (29.57%) respectively. similar findings reported by Motior Rahman *et al*., (2005); Kumar *et al*., (2015); Jayprakash *et al.,* (2005) and Kannan *et al*., (2013).

Chemical properties of soil

The maximum pH of soil was found in the treatment T_9[@ 100% RDF+ 5 kg Boron ha^{-1} (basal dose)] which was at 0-15 cm (6.90)and at 15-30 cm (6.92) followed byT_8[@ 100% RDF+ 0.5% B (foliar spray)] at 0-15 cm (6.87) and at 15-30 cm (6.88) while the minimum pH values of the result were found in treatment T_1[@ 0% RDF + 0% Boron] which was at 0-15 cm (6.71) and at 15-30 cm (6.73) respectively. The maximum EC (dSm^{-1}) of soil was found in treatment T_1[@ 0% RDF + 0% Boron]which was at 0-15 cm (0.268dSm^{-1}) and at 15-30 cm (0.264dSm^{-1}) followed byT_2[@ 0% RDF+ 0.5% B (foliar spray)] at 0-15 cm (0.264dSm^{-1})and at 15-30 cm (0.261dSm^{-1}) while the minimum values of the result were found in treatment T_9[@ 100% RDF+ 5 kg Boron ha^{-1} (basal dose)] which was at 0-15 cm (0.229dSm^{-1}) and at 15-30 cm (0.224dSm^{-1}) respectively. Similar results recorded by Masih *et al*., 2018; Singh *et al*., 2017; Kumar *et al*., 2015.

The maximum Organic Carbon (%)of soil was found in the treatment T_9[@ 100% RDF+ 5 kg Boron ha^{-1} (basal dose)] which was at 0-15 cm (0.561%)and at 15-30 cm (0.550 %) followed byT_8[@ 100% RDF+ 0.5% B (foliar spray)] at 0-15 cm (0.560%) and at 15-30 cm (0.549%) while the minimum values of the result were found in treatment T_1[@ 0% RDF + 0% Boron] which was at 0-15 cm (0.553%) and at 15-30 cm (0.542%) respectively. The maximum Available Nitrogen (kg ha^{-1}) of soil was found in treatment T_9 [@ 100% RDF + 5 kg Boron ha^{-1} (basal dose)] which was at 0-15 cm (265.45 kg ha^{-1}) and at 15-30 cm (225.22 kg ha^{-1}) followed by T_8 [@ 100% RDF + 0.5% B (foliar spray)] at 0-15 cm (263.29 kg ha^{-1}) and at 15-30 cm (223.03 kg ha^{-1}) while the minimum values of the result were found in treatment T_1 [@ 0% RDF + 0% Boron] which was at 0-15 cm (235.18 kg ha^{-1}) and at 15-30 cm (210.63 kg ha^{-1}) respectively. Similar result has been recorded by Meena *et al*., 2018(ac); Gupta *et al*., 2018; Ruth *et al*., 2018 and Singh *et al*., 2017.

The maximum Available Phosphorus (kg ha^{-1}) of soil was found in treatment T_9 [@ 100% RDF + 5 kg Boron ha^{-1} (basal dose)] which was at 0-15 cm (27.41 kg ha^{-1}) and at 15-30 cm (25.53 kg ha^{-1}) followed by T_8 [@ 100% RDF + 0.5% B (foliar spray)] at 0-15 cm (27.29 kg ha^{-1}) and at 15-30 cm (25.40 kg ha^{-1}) while

Table 1. Effect of Boron as basal and foliar application with NPK on Physico-chemical properties of soil in maize.

Treatment	Bulk density ($Mg\ m^{-3}$)		Particle density ($Mg\ m^{-3}$)		Pore space (%)		Water holding capacity (%)		pH (1:2.5) v/w		EC (dSm^{-1})		Organic carbon (%)		Available Nitrogen ($kg\ ha^{-1}$)		Available Phosphorus ($kg\ ha^{-1}$)		Available Potassium ($kg\ ha^{-1}$)		Available boron ($mg\ kg^{-1}$)	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
T_1	1.286	1.289	2.520	2.528	38.32	32.72	30.57	32.57	6.71	6.73	0.268	0.264	0.553	0.542	235.18	210.63	25.62	20.40	191.67	190.42	0.61	0.52
T_2	1.288	1.291	2.521	2.530	40.62	34.24	31.18	32.28	6.74	6.77	0.264	0.261	0.554	0.543	238.20	212.76	25.71	20.25	192.69	191.72	0.63	0.54
T_3	1.289	1.293	2.522	2.533	41.85	36.18	32.42	34.74	6.76	6.79	0.259	0.256	0.555	0.544	242.51	213.36	25.75	21.11	193.87	191.92	0.65	0.55
T_4	1.291	1.296	2.520	2.535	39.44	33.28	31.89	34.42	6.78	6.80	0.253	0.250	0.556	0.545	247.72	215.74	26.61	22.57	195.92	193.34	0.70	0.59
T_5	1.293	1.299	2.522	2.538	40.50	37.42	33.72	32.08	6.81	6.82	0.248	0.244	0.557	0.546	250.54	216.56	26.71	22.12	196.38	195.28	0.73	0.60
T_6	1.297	1.301	2.521	2.540	41.56	40.56	32.29	33.87	6.83	6.84	0.243	0.239	0.558	0.547	252.88	217.31	26.56	23.22	196.84	194.45	0.75	0.61
T_7	1.299	1.304	2.525	2.543	39.28	37.09	32.82	34.75	6.85	6.86	0.235	0.232	0.559	0.548	258.72	221.69	27.29	24.14	197.46	195.86	0.77	0.63
T_8	1.303	1.307	2.524	2.546	41.49	36.86	31.42	35.87	6.87	6.88	0.231	0.227	0.560	0.549	263.29	223.03	27.29	25.40	199.07	193.78	0.77	0.64
T_9	1.305	1.310	2.526	2.548	42.87	37.50	34.62	36.95	6.90	6.92	0.229	0.224	0.561	0.550	265.45	225.22	27.41	25.53	199.32	193.54	0.78	0.66
F test	NS	NS	NS	NS	S	S	S	S	NS	NS	NS	NS	S	S	S	S	S	S	S	S	S	S
SEm ±	-	-	-	-	0.74	0.61	4.14	5.11	-	-	-	-	0.10	0.01	4.72	4.57	2.03	1.57	3.12	4.12	0.08	0.12
CD (P = 0.05)	-	-	-	-	0.36	0.35	2.36	3.87	-	-	-	-	0.04	0.05	2.20	2.40	0.98	0.68	1.01	1.99	0.03	0.05

the minimum values of the result were found in the treatment T_1 [@ 0% RDF + 0% Boron] which was at 0-15 cm (25.62 kg ha^{-1}) and at 15-30 cm (20.40 kg ha^{-1}) respectively.

The maximum Available Potassium (kg ha^{-1}) of soil was found in the treatment T_9 [@ 100% RDF + 5 kg Boron ha^{-1} (basal dose)] which was at 0-15 cm (199.32 kg ha^{-1}) and at 15-30 cm (193.54 kg ha^{-1}) followed by T_8 [@ 100% RDF + 0.5% B (foliar spray)] at 0-15 cm (199.07 kg ha^{-1}) and at 15-30 cm (193.78 kg ha^{-1}) while the minimum values of the results were found in treatment T_1 [@ 0% RDF + 0% Boron] which was at 0-15 cm (191.67 kg ha^{-1}) and at 15-30 cm (190.42 kg ha^{-1}) respectively. The results were in agreement with findings by Gupta *et al*., (2018); Ruth *et al*., (2018) and Singh *et al*., (2017).

The Available Boron (mg kg^{-1})of soil was found in the treatment T_9 [@ 100% RDF + 5 kg Boron ha^{-1} (basal dose)] which was at 0-15 cm (0.78mg kg^{-1}) and at 15-30 cm (0.66mg kg^{-1}) followed by T_8 [@ 100% RDF + 0.5% B (foliar spray)] at 0-15 cm (0.77mg kg^{-1}) and at 15-30 cm (0.64 mg kg^{-1}) while the minimum values of the result were found in the treatment T_1 [@ 0% RDF + 0% Boron] which was at 0-15 cm (0.61mg kg^{-1}) and at 15-30 cm (0.52mg kg^{-1}) respectively. Similar results were found by Islam *et al.,* 2018.

CONCLUSION

In the present investigation, it was apparent that application of NPK and Boron as foliar spray and basal dose fertilizer in treatment T_9 (@ 100% RDF + 5 kg B ha^{-1} (basal dose)) was found on physical and chemical parameters of soil such as bulk density, particle density, % pore space, water holding capacity, EC, pH, organic carbon, available N, P and K and boron than other treatment combinations. Thus it can be suggested that different levels of NPK and Boron fertilizer improved soil nutrient availablity as well improvised the morphological growth in maize and added contribution to the protein and carbohydrate concentration.

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