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Effect of Multinutrient (NPKZn) Briquettes on Availability and Movement of Nitrogen, Phosphorus, Potassium and Zinc in Soils

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Authors' contributions

This work was carried out in collaboration between all authors. Author BHS carried out the entire research work and wrote the paper. Authors VDP and MP performed as a chairman and advisory committee member. Author VMB helped to carried out research work. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted to study the effect of multinutrient (NPKZn) briquettes on the availability and movement of Nitrogen (N), Phosphorus (P), Potassium (K) and Zinc (Zn) in soils. The experiment was laid out in a Randomised Block Design with five treatments and four replications, conducted at the College of Agriculture Parbhani during the Kharif season of 2015-2016. The movement of nutrient N was maximum in treatment receiving recommended dose of fertilizer through fertigation at all depths followed by the application of briquette in root rhizosphere. The movement of nutrient P was observed at a lower magnitude, however, the P movement was maximum in soluble fertilizers and briquettes. The mobility rate of K, was reduced due to the synergetic effect of the slow release of N and Zn. The Zn content was more at 15 and 30 cm depth as compared to 30 cm distance from the plant. The movement of Zn was found to be the highest in

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the treatment which received soluble fertilizer. The maximum value of P and K were observed in treatments which received soluble fertilizer and the treatment receiving an application of NPK through briquette was found significantly superior over all other treatments.

Keywords: Nitrogen; phosphorus; potassium; zinc; briquettes.

1. INTRODUCTION

Application of chemical fertilizers leads to the loss of soil fertility due to the imbalanced use of fertilizers which have adversely affected agricultural productivity and caused soil degradation. For sustainable agriculture scientific and efficient use of fertilizers is important. A number of investigators has shown that there is a definite and nearly constant requirement of nitrogen, phosphorus and potassium for the production of high yielding varieties of the crop [1]. Nitrogen (N) is the most important and key nutrient for production, as regarded all over the world for its huge requirements and instability in the soil. So, in order to reduce the nitrogen loss, deep placement of all essential fertilizers, may be more efficient and farmers can be more benefited from this compared to the broadcast method [2, 3,4]. In Bt cotton cultivation, farmers from Marathwada region usually, use non-urea fertilizer as basal during final land preparation. An effective alternative may be the use of Urea Super Granule (USG) or NPK briquette for higher yield and efficient use of nitrogen in Bt cotton cultivation [5]. Briquettes are entirely mineral in their formulation and are manufactured by a fertilizer briquettes machine. The briquettes are a unique fertilizer concept apart from the conventional fertilizers in which the fertilizer is manufactured into a briquette approximately as the size of the end of one`s finger (about 2.75 gms) as opposed to the more common granular prill sized fertilizers or liquid fertilizers [6]. The land application of briquette is also unique in that it is banded below the soil surface between planted rows. The theory behind the briquette is that a smaller surface area to volume ratio has been shown to significantly reduce nitrogen loss through ammonia volatilisation [7]. Surface-applied urea is reported to reach nitrogen loss as high as 35% however; buried briquettes only lose approximately 4% of its nitrogen, which is a considerable improvement in nitrogen use efficiency [8]. The low use efficiency of N and P is because of various reasons such as volatilisation, denitrification, surface runoff, leaching losses for nitrogen and fixation of phosphorus in soil. Deep placement of fertilizers such as, Urea Super Granules (USG) and NPK briquette into the anaerobic soil zone is an effective method to reduce volatilisation loss [9]. Deep placement of urea super granule (USG) at 8-10 cm soil depth can save 30% N compared to Prilled Urea (PU), increases absorption rate, improves soil health and ultimately increases rice yield [10]. Moreover, deep placement method of fertilizer application is environment-friendly and will not decrease the normal fertility of land [11]. The main objective of this study was to investigate the effect of multinutrient briquettes on availability and movement of Nitrogen, Phosphorus, Potassium and Zinc in soils.

2. MATERIALS AND METHODS

A field experiment was conducted at the College of Agriculture Parbhani farm during the Kharif season 2015-2016. The experiment was laid out in a randomised block design with three replications and 5 treatments. A plot size of 7.2 × 5.4 m^2 with inter and intra row spacing of 180 cm and 30 cm respectively used and the soil samples collected at 15(H)-15(V) cm, 15(H)-30(V) cm, 30(H)-15(V) cm and 30(H)-30(V) cm depth i.e. H-Horizontal distance, V-Vertical distance. The initial soil sample was taken before planting. The pH was found neutral to alkaline (7.73) by using potentiometer method of 1:2 soil-water suspension on digital pH meter, low organic carbon content (3.30 g/kg) was analysed by using Walkley and Black method (wet oxidation method) and available nutrient like low nitrogen (140.0 kg/ha) was measured by alkaline potassium permanganate method, whereas, low available phosphorus (8.50 kg/ha) was measured by using 0.5 M sodium bicarbonate as an extractant and absorbance was read in the spectrophotometer. High available potassium (699.26 kg/ha) was measured by using neutral normal ammonium acetate in the flame photometer and available zinc (0.53 mg/kg) was measured by using DTPA extractant. Treatments detail are as follows:

T_1: Absolute Control (No fertilizer application)
T_2: Soil application of 120:60:60 by N, P_2O_5, K_2O kg/ha and drip irrigation

- T_3: RDF through fertigation (soluble fertilizer: 80:40:40 NPK kg/ha)
- T_4: 120: 60: 60 kg NPK kg/ha through briquettes with drip irrigation
- T_5: Application of NPK + micronutrient briquettes (120:60: 60 NPK kg/ha +20 kg/ ha) $ZnSO_4$

3. RESULTS AND DISCUSSION

3.1 Movement of Available Nitrogen

Results of the investigation showed that available N content of the soil was influenced by the application of recommended dose of fertilizer through a fertigation at various growth stages of crop i.e., 30, 60, and at last picking stage in the soil of Marathwada region. The highest available nitrogen at different depth was observed in treatment receiving RDF through fertigation likewise (193.64 kg/ha) at 15-15 cm depth, (208.61 kg/ha) at 15-30 cm depth, (193.64 kg/ha) at 30-15 cm depth and at 30-30cm depth available nitrogen was 170.91 kg/ha and also lowest available nitrogen was observed in treatment without fertilizer i.e.159.15 kg/ha at 15-15 cm depth, 165.06 kg/ha at 15-30 cm depth. At 30-15 cm depth it was 166.99 kg/ha and 165.23 kg/ha at 30-30 cm depth. At 60 DAS (flowering stage), available nitrogen status of soil ranged from 165.23 to 170.91 kg/ha at 15-15 cm depth, at 15-30 cm depth values were 161.5 to 181.8 kg/ha, at 30-15 cm depth available nitrogen status of soil ranged from 154.89 to 187.42 kg/ha, at 30-30 cm depth available nitrogen status of soil ranged from 182.20 to 189.01 kg/ha. At last picking, treatment T_3 receiving RDF through a fertigation was found highest and significant available nitrogen 206.93 kg/ha which was at par with T_5, T_2 and T_4 treatments at 15-15 cm depth, at 15-30 cm depth highest available nitrogen value was observed in T_3 (217.16 kg/ha) and lowest value was observed in T_1 (191.58 kg/ha) . These results show that T_3 was significantly superior to other treatments. Similar findings were also reported by Bharambe et al. [12]. The available nitrogen content was significantly higher under N applied through fertigation and briquette as compared with soil application. Reddy et al. [4] concluded that under fertigation, benefits were with more number of split application of RDF than the present method of drip application. Tekale et al. [13] also reported that the more splits result in the efficient utilisation of applied nitrogen through fertigation than band placement. Similar results are recorded by Sankaranarayanan et al. [3], More and Shindi [14] reported a slow release of N through NP and NPK briquette. In respect with the nitrogen movement from the surface to 15cm and 30 cm depth, it was noticed that more nitrogen was retained by treatment fertigation at all depths.

3.2 Movement of Available Phosphorus in Soil

The effects of briquettes on the movement of available phosphorus at different horizontal and vertical distances from the point of placement of NPKZn fertilizer briquettes are presented in Table 2. At 30DAS (square formation stage) the highest available phosphorus at different depth was observed in RDF through fertigation (9.39 kg/ha) at 15-15 cm depth, (9.73 kg/ha) at 15-30 cm depth (9.50 kg/ha) at 30-15 cm depth and (10.20 kg/ha) at 30-30 cm depth. . While lowest available phosphorus was observed in the treatment without fertilizer about (7.53 kg/ha) at 15-15 cm depth, (6.95 kg/ha) at 15-30cm depth, at 30-15 cm depth (7.99 kg/ha) and (7.41kg/ha) at 30-30 cm depth. The application of briquette was performed intermediate between fertigation and recommended a dose of fertilizer through conventional method. At 60 DAS and at last picking available phosphorus status of soil in T_3 was superior among other treatment followed by NPK and NPK+Zn briquette. The movement of nutrient phosphorus was observed at a lower magnitude. The concentration of available phosphorus at the applied location and sampled location (15-15, 15-30, 30-15 and 30-30 cm) depth could not vary significantly. However, the phosphorus received in the form of soluble fertilizers and briquette showed a higher rate of phosphorus movement which might be continuum because of continuous release of phosphorus from soluble fertilizer and briquettes. Similar observations are also reported by Bharambe et al. [12], O'Neill et al. [15] and Bacon and Davey [16].

3.3 Movement of Available Potassium in Soil

The perusal of the data indicating the available K content in soil at 30, 60 DAS and at last picking are presented in Table 3. The available potassium content at 30 DAS ranged from 781.20 to 851.59 kg/ha at 15-15 cm depth, 701.30 to 708.14 kg/ha at 15-30 cm depth, 751.54 to 790.46 kg/ha at 30-15 cm depth and at 30-30 cm depth 719.01 to 829.36 kg/ha respectively. At 60 days after sowing,

Table 1. Effects of briquettes on movement of available nitrogen (kg/ha) in soil

Treatments	30 DAS depth (cm)				60 DAS depth (cm)				At last picking depth(cm)			
	15-15	15-30	30-15	30-30	15-15	15-30	30-15	30-30	15-15	15-30	30-15	30-30
T_1	159.15	165.06	166.91	165.23	163.91	161.50	154.89	182.20	202.94	179.53	168.12	191.58
T_2	166.99	173.31	170.91	167.77	167.77	155.21	164.40	187.86	205.75	189.72	159.93	195.99
T_3	193.64	208.91	193.64	168.23	165.23	181.83	187.44	189.00	204.48	163.07	187.72	198.26
T_4	177.96	196.95	190.51	165.51	168.23	176.42	183.44	183.70	206.93	217.16	187.72	194.29
T_5	177.96	190.96	168.56	170.91	170.91	155.40	155.20	184.01	205.49	164.64	170.56	193.86
G.M	177.50	187.03	178.18	163.91	163.91	166.01	169.07	185.35	205.12	173.89	171.85	194.79
S.E ±	6.62	5.80	5.75	7.18	7.19	5.77	5.40	5.23	5.90	7.55	5.80	5.98
CD at 5%	19.94	17.89	17.31	22.13	22.15	17.79	18.79	16.65	18.19	22.73	17.46	18.03

DAS-Days after sowing, G.M- Grand mean, SE(m)- Standard error mean, C.D- Critical difference at 5%

Table 2. Effects of briquettes on movement of available phosphorus (kg/ha) in soil

Treatments	30 DAS depth (cm)				60 DAS depth (cm)				At last picking depth(cm)			
	15-15	15-30	30-15	30-30	15-15	15-30	30-15	30-30	15-15	15-30	30-15	30-30
T_1	7.53	6.95	7.99	7.41	7.18	7.65	7.07	7.65	7.65	7.15	7.53	7.88
T_2	8.34	8.81	7.88	8.11	7.67	7.53	8.81	8.11	8.46	8.11	8.34	8.34
T_3	9.39	9.73	9.50	10.20	10.08	9.73	9.96	9.50	9.73	9.96	9.04	9.73
T_4	9.15	9.39	8.66	9.73	9.53	9.62	9.39	9.39	8.92	9.50	8.81	9.04
T_5	8.34	9.13	8.95	8.34	9.74	9.50	9.50	9.38	9.15	8.69	8.69	9.39
G.M	8.55	8.97	9.12	8.75	8.86	8.81	8.94	8.81	8.78	8.78	8.48	8.88
S.E ±	0.20	0.17	0.22	0.22	0.20	0.14	0.23	0.22	0.19	0.14	0.18	0.40
CD at 5%	0.64	0.54	0.68	0.68	0.62	0.43	0.71	0.69	0.60	0.44	0.56	1.24

DAS-Days after sowing, G.M- Grand mean, SE(m)- Standard error mean, C.D- Critical difference at 5%

Table 3. Effects of briquettes on movement of available potassium (kg/ha) in soil

Treatments	**30 DAS depth (cm)**				**60 DAS depth (cm)**				**At last picking depth(cm)**			
	15-15	**15-30**	**30-15**	**30-30**	**15-15**	**15-30**	**30-15**	**30-30**	**15-15**	**15-30**	**30-15**	**30-30**
T_1	781.20	701.30	751.54	719.01	731.51	720.41	703.64	650.55	809.84	725.78	763.30	763.30
T_2	764.40	704.36	770.60	763.02	693.86	722.63	759.00	684.60	759.64	729.80	799.41	768.88
T_3	851.59	708.14	790.46	829.36	824.60	753.10	864.64	839.33	848.41	821.60	868.86	799.41
T_4	821.60	707.44	775.83	770.84	741.72	741.72	790.16	796.43	814.88	753.48	786.07	786.07
T_5	826.00	706.16	789.88	816.39	753.10	736.96	789.88	764.20	840.00	763.70	792.96	792.96
G.M	808.96	705.48	795.66	779.73	748.95	743.91	781.49	747.02	814.55	758.88	802.16	775.27
S.E **±**	15.46	11.89	8.65	18.34	14.67	18.33	23.15	32.53	14.03	12.23	13.67	3.08
CD at 5%	46.41	36.64	26.66	55.20	45.21	55.16	69.66	97.90	42.24	36.81	41.14	9.56

DAS-Days after sowing, G.M- Grand mean, SE(m)- Standard error mean, C.D- Critical difference at 5%

Table 4. Effects of briquettes on movement of available zinc (mg/kg) in soil

Treatments	**30 DAS depth (cm)**				**60 DAS depth (cm)**				**At last picking depth(cm)**			
	15-15	**15-30**	**30-15**	**30-30**	**15-15**	**15-30**	**30-15**	**30-30**	**15-15**	**15-30**	**30-15**	**30-30**
T_1	0.90	1.05	1.36	0.90	1.23	0.61	0.27	0.97	0.63	0.85	0.61	0.90
T_2	0.97	1.23	1.03	1.09	1.32	0.64	0.33	1.38	0.77	0.85	0.64	1.09
T_3	1.54	1.39	2.15	1.49	2.28	0.85	1.01	1.54	1.16	1.24	0.85	1.48
T_4	1.38	1.26	1.36	1.13	1.36	0.81	0.87	0.97	0.81	1.20	0.69	1.13
T_5	1.42	1.56	2.46	1.80	2.44	0.89	1.13	1.92	1.36	1.12	0.89	1.50
G.M	1.30	1.38	1.56	1.18	1.52	0.72	0.68	1.30	0.84	1.05	0.72	1.18
S.E **±**	0.33	0.33	0.11	0.28	0.01	0.41	0.07	0.33	0.05	0.02	0.41	0.28
CD at 5%	1.00	1.01	0.36	0.85	0.05	0.42	0.22	1.00	0.16	0.07	0.42	0.85

DAS-Days after sowing, G.M- Grand mean, SE(m)- Standard error mean, C.D- Critical difference at 5%

the maximum available potassium was recorded due to the application of recommended dose of fertilizer through fertigation. It was found that at 15cm surface layer the potassium content was more as compared to 30 cm subsurface layer. Treatment receiving RDF through fertigation was significantly superior over the rest of all treatments. The available potassium showed a decreasing trend towards maturity. At harvesting of Bt cotton, it was increased from 809.84 to 848.4 kg/ha at 15- 15 cm depth, at 15-30 cm depth it was increased from 725.78 to 821.60 kg/ha, at 30-15 cm depth values increased from 763.30 to 868.86 kg/ha and at 30-30 cm depth it was increased from 763.30 to 799.40 kg/ha. The treatment RDF through fertigation was statistically significant over the rest of the treatment. The availability of potassium was considerably increased by the nitrogen levels applied through drip and briquette application as compared to soil application. Similar observations are reported by Reddy et al. [4] who also concluded that under drip irrigation more benefits and more availability with more number of split application of RDF was found than the present method of fertilizer application. Similarly, application of briquette to low paddy and sugarcane proved to be a better opinion to provide potassium on continuous basis even under aerobic conditions.

3.4 Movement of Available Zinc in Soil

The data on available Zn content in soil at 30, 60 DAS and at last picking at the various horizontal spread and vertical depth, as influenced by various treatments are presented in Table 4. Tha result revealed that the available zinc content at 30 DAS was maximum in treatment receiving RDF through fertigation. Similar results were also recorded at 60 DAS, boll formation, last picking. Similar finding was reported by Bharambe et al. [12], Tekale et al. [13], Sankaranarayanan et al. [3], Tapkeer [17].

4. CONCLUSIONS

It may be concluded that maximum nitrogen was retained by the treatment of fertigation at all depths followed by application of briquette in root rhizosphere. The movement of nutrient phosphorus was observed at a lower magnitude. It did not vary significantly, however, the phosphorus movement was maximum in soluble fertilizers and briquettes. The mobility rate of potassium is generally high, but in the present research mobility of potassium was reduced due to the synergetic effect of the slow release of nitrogen and zinc. The zinc content was more at 15 and 30 cm depth as compared to 30 cm distance from the plant. The movement of zinc was found to be the highest in treatment receiving RDF through fertigation.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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