

Research Paper

EFFECT OF LIME AND SOWING DATE ON SOIL PROPERTIES WITH YIELD, QUALITY AND NUTRIENT UPTAKE BY SUNFLOWER (*Helianthus annus L.*)

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Abstract

A field trial was conducted in Instructional farm, Krishi Vigyan Kendra, Angul of Odisha during *rabi* seasons of 2010-11 and 2011-12 to study effect of lime and sowing date on soil properties with yield, quality and nutrient uptake by sunflower under irrigated condition. The experiment comprised of four main plot treatments comprising different levels of lime requirement viz. . T₁-RDF(60:80:60 kg ha⁻¹), T₂-RDF+ PMS @25% LR, T₃-RDF+ PMS @50% LR and T₄-RDF+ PMS @100% LR and three subplots viz D₁-15th October, D₂-29th October, D₃-13th November in split plot design with three replications. The experiment showed that application of RDF+ 100% LR recorded maximum seed yield, total dry matter yield , protein content and oil content which is 35.2, 24.2, 22.9 and 3.9 % higher than no lime application. The same treatment increased the uptake of N, P, K, Ca and Mg by 82.7, 72.1, 8.9, 128.8 and 137.6%, respectively than application of no lime. The post harvest soil status also varied significantly and maximum pH(6.75), available P(36.67 kg ha⁻¹), available K(343.49 kg ha⁻¹),exchangeable Ca[16.28 mol(p⁺) kg⁻¹] and exchangeable Mg[5.18 mol(p⁺) kg⁻¹] were recorded with 100% LR with RDF. Sowing of sunflower during 15th October also resulted the maximum seed yield(11.83 q ha⁻¹), total dry matter yield (31.82 q ha⁻¹), protein(16.92%), oil content(44.27%), uptake of N (89.41 kg ha⁻¹), uptake of P (11.04 kg ha⁻¹), uptake of K (100.78 kg ha⁻¹), uptake of Ca (77.67 kg ha⁻¹) and uptake of Mg (42.34 kg ha⁻¹). Higher pH(6.16), available N(221.89 kg ha⁻¹),P(26.21 kg ha⁻¹), K(317.64 kg ha⁻¹),exchangeable Ca[9.04 mol(p⁺) kg⁻¹] and exchangeable Mg[3.81 mol(p⁺) kg⁻¹] were also observed in 15th October sowing. Thus, application of lime@100% LR with RDF and sowing on 15th October was found to be beneficial for maximizing the yield of sunflower and improvement of quality and uptake of nutrients and fertility status of acid soil.

Key words: Lime, Sowing date, Sunflower, Nutrient uptake, Soil properties.

INTRODUCTION

Sunflower (*Helianthus annus L.*) is an important oilseed crop cultivating for its premier oil for manifold uses. Sunflower competes in state oilseed scenario with the other four major oilseed crops viz. Groundnut, sesamum, mustard and niger. In Odisha, it is grown in an area of

0.24 lakh hectare with a production of 0.28 lakh tonnes with a productivity of 11.81 qha⁻¹[1]. Its productivity is much lower than the national average. One of the major problems in low productivity is due to soil acidity. Apart from low pH, acid soils are generally low in organic carbon, N and P and medium to high in K with deficient in Ca and Mg[2]. Paper mill sludge is produced as a byproduct of the paper industry and dumped outside after removal from sludge tanks which contains primarily CaCO₃ with small quantities of MgCO₃[3]. PMS could be profitably used as an amendment in light textured acid soils at a lower dose @ 1000 kg ha⁻¹ due to its faster solubility[4]. Liming is a widely accepted amelioration practices for efficient utilisation of native and applied soil nutrients and economic use of added fertilise sources [5]. Soil ammendment is the need of the day, because of its sustainability and higher productivity. Keeping in view the importance of lime in sunflower, an experiment was conducted to study the effect of different levels of lime and sowing date on yield, quality, nutrient uptake and changes in soil properties.

MATERIALS AND METHODS

A field experiment was conducted in Instructional farm, Krishi Vigyan Kendra, Angul district in mid central table land zone of Odisha during *rabi* seasons of 2011-11 and 2014-12 to study effect of lime and sowing date on soil properties with yield, quality and nutrient uptake by sunflower. The geographical location of the area has 84° 16' to 85° 23' E longitude and 20° 31' to 21° 41' N latitude and average elevation of 300 m above mean sea level. The average rainfall in both the year during the study period from October to February was 124.5 mm. The mean maximum and mean minimum temperature registered in both the year was 32.8° C and 14.5° C respectively. The soil of the experimental site was slightly acidic in reaction (pH-5.52), sandy loam in texture with medium in organic carbon (0.45 %), available nitrogen(212.6 kg ha⁻¹), phosphorus(15.27 kg ha⁻¹), potash(234.85 kg ha⁻¹), exchangeable calcium[3.76mol(p⁺) kg⁻¹] and exchangeable magnesium[2.68 mol(p⁺)kg⁻¹] contents. The experiment involved four main plot treatments comprising different levels of lime requirement viz. T₁-RDF(60:80:60 kg ha⁻¹), T₂-RDF+ PMS @25% LR, T₃-RDF+ PMS @50% LR and T₄-RDF+ PMS @100% LR and three subplots viz D₁-15th October, D₂-29^h October, D₃-13th November. Experiment was conducted in split plot design with three replications in a fixed layout. Recommended package of practices were followed for growing sunflower cv.KBSH 1 during both the year. The recommended fertilizer dose were N:P:K 60:80:60 kg ha⁻¹ respectively. Full dose of P and K as basal and N in 3 splits i.e 50% as basal, 25% at 25 DAS and 25% at 45 DAS. The liming material paper mill sludge @12.5q ha⁻¹ was applied during final land preparation. Four numbers of irrigations were given during 4-5 leaf stages, button formation, flowering and seed setting. Soil samples before sowing and after harvest of crop were collected and analysed for chemical properties like pH, Organic carbon(OC), available Nitrogen(N), Phosphorus(P), Potassium(K) and exchangeable Calcium(Ca), Magnesium (Mg). [6,7,8,9,10]. The plant samples were analysed for major nutrients by standard methods [11]. Estimation of yield and quality i.e protein and oil content were taken. The datas were statistically analyzed applying the techniques of analysis of variance and the significance of different sources of variations were tested by error mean square of Fisher Snedecor's 'F' test at probability level 0.05 [12].

RESULTS AND DISCUSSION

Seed yield and total dry matter production

Application of lime through paper mill sludge @ 25, 50, 100% LR with RDF (60:80:60 kg ha⁻¹) increased the seed yield by 14.7, 23.7 and 35.2, respectively over the treatment receiving RDF with no lime, thereby signifying the graded response to lime.(Table 1). The total dry matter production was also increased by 24.2, 15.5 and 8.7% respectively due to addition of lime through paper mill sludge over the treatment receiving no lime. Among the three date of sowing of sunflower, maximum dry seed yield of 11.83 q ha⁻¹ and dry matter production 31.82 q ha⁻¹ was recorded on 15th October sowing [13].

Nutrient uptake by crop

Application of increasing dose of lime (Table 2) significantly enhanced the nutrient uptake by sunflower crop. The treatment receiving 100% LR increased the uptake of N, P, K, Ca and Mg by 82.8, 72.1, 8.9, 128.8 and 137.6%, respectively over the treatment receiving no lime. Among three date of sowing of sunflower, maximum uptake N, P, K, Ca and Mg was observed on 15th October sowing. The increased uptake of N, P, K, Ca and Mg 89.41, 11.04, 100.78, 77.67 and 42.34 kg ha⁻¹, respectively by sunflower may be attributed to their better availability in lime-amended soil [14].

Protein and Oil content

The protein and oil content of sunflower seed was affected significantly by different levels of lime application (Table 3). Application of 100% lime increased protein content by 23% over no lime application. Maximum protein content (16.92%) was recorded on 15th October sowing which was significantly higher than rest of sowing date. Application of 100% lime recorded 44.25% which is 3.9% higher than no lime application. Maximum oil content to the tune of 44.27% was obtained on 15th October sowing [15].

Changes in available nutrient status

Among the treatments (Table 4) the pH varies between 5.76 to 6.75 by addition of different level of lime with RDF. Application of lime significantly increased available nitrogen content in post harvest soil (4.14 to 11.21 kg ha⁻¹) from initial soil status and maximum (223.81 kg ha⁻¹) was obtained in application with 50% LR which is 10.4% higher than no lime application. The increases in availability of N may be due to accelerated rate of decomposition and mineralisation of organic matter owing to increased biological activity of soil. The results indicated that significantly higher Phosphorus content (36.67 kg ha⁻¹) of post harvest soil was observed with 100% lime application which is 21.4 kg ha⁻¹ higher than initial soil status. The improvement in P availability might be due to dissociation of Fe and Al phosphate complexes present in acid soil and to some extent increased mineralisation of organic. The available Potassium content differed significantly (30.72 to 108.64 kg ha⁻¹) and maximum was obtained with application of 100% lime. The increase in potassium availability may be due to release of K from non-exchangeable fractions to available form. Maximum exchangeable calcium, [16.28 mol(p⁺) kg⁻¹] and magnesium [5.18 mol(p⁺) kg⁻¹] content was obtained in the treatment receiving 100% lime attributed due to the dissolution of calcium carbonate and other insoluble forms of calcium and magnesium by root exudates and also by various products of microbial activity. Similarly, on 15th October sowing post harvest soil properties *i.e.* pH, N, P, K, Ca and Mg was 11.6, 4.4, 71.6, 35.3, 140 and 42% higher respectively than initial soil status [16].

Table 1. Effect of different levels of lime application and sowing date on dry seed and total dry matter yield

Treatment	Dry seed yield (q ha ⁻¹)	Total dry matter yield (q ha ⁻¹)
Lime levels		
T ₁ -RDF	9.3	26.86
T ₂ -RDF+ PMS @25% LR	10.67	29.2
T ₃ -RDF+ PMS @50% LR	11.5	31.03
T ₄ -RDF+ PMS @100% LR	12.57	33.35
SEm _±	0.086	0.08
C.D at 5 %	0.286	0.266
Date of sowing		
D ₁ -15 th October	11.83	31.82
D ₂ - 29 th October	11.08	30.17
D ₃ -13 th November	10.13	28.34
SEm _±	0.048	0.046
C.D at 5 %	0.139	0.133

Table 2. Effect of different levels of lime application and sowing date on total uptake of major nutrients by sunflower

Treatment	Nitrogen (kg ha ⁻¹)	Psosphorus (kg ha ⁻¹)	Potassium (kg ha ⁻¹)	Calcium (kg ha ⁻¹)	Magnesium (kg ha ⁻¹)
Lime levels					
T ₁ -RDF	61.63	7.73	95.47	44.27	22.43
T ₂ -RDF+ PMS @25% LR	79.73	9.77	101.25	65.3	35.22
T ₃ -RDF+ PMS @50% LR	95.62	11.45	96.32	85.61	46.31
T ₄ -RDF+ PMS @100% LR	112.65	13.3	103.96	101.28	53.3
SEm±	0.559	0.058	0.154	1.376	0.431
C.D at 5 %	1.931	0.2	0.528	4.753	1.484
Date of sowing					
D ₁ - 15 th October	89.41	11.04	100.78	77.67	42.34
D ₂ - 29 th October	87.21	10.62	98.72	73.72	39.09
D ₃ -13 th November	85.6	10.03	98.25	70.95	36.52
SEm±	0.051	0.012	0.05	0.19	0.093
C.D at 5 %	0.15	0.036	0.146	0.554	0.271

Table 3. Effect of different levels of lime application and sowing date on protein and oil content (%) of sunflower seed

Treatment	Protein content (%)	Oil content (%)
Lime levels		
T ₁ -RDF	14.23	42.58
T ₂ -RDF+ PMS @25% LR	15.19	43.44
T ₃ -RDF+ PMS @50% LR	16.3	43.82
T ₄ -RDF+ PMS @100% LR	17.49	44.25
SEm±	0.082	0.051
C.D at 5 %	0.266	0.163
Date of sowing		
D ₁ -15 th October	16.92	44.27
D ₂ - 29 th October	15.96	43.53
D ₃ - 13 th November	14.53	42.76
SEm±	0.062	0.042
C.D at 5 %	0.18	0.123

Table 4. Effect of different levels of lime application and sowing date on changes in available nutrient status

Treatment	pH	Available Nitrogen (kg ha ⁻¹)	Available Psosphorus (kg ha ⁻¹)	Available Potassium (kg ha ⁻¹)	Exchangeable Calcium [mol(p ⁺)kg ⁻¹]	Exchangeable Magnesium [mol(p ⁺)kg ⁻¹]
Lime levels	5.52	212.6	15.27	234.85		
T ₁ -RDF	5.52	202.66	15.81	265.57	2.87	1.97
T ₂ -RDF+PMS						
@25% LR	5.76	216.74	20.84	312.01	5.51	3.21
T ₃ -RDF+PMS						
@50% LR	6.34	223.81	29.23	332.78	9.81	3.75
T ₄ -RDF+PMS						
@100% LR	6.75	219.64	36.67	343.49	16.28	5.18
SEm±	0.013	0.163	0.235	0.408	0.121	0.048
C.D at 5 %	0.044	0.561	0.015	1.411	0.418	0.165
Date of sowing						
D ₁ - 15 th						
October	6.16	221.89	26.21	317.64	9.04	3.81
D ₂ - 29 th						
October	6.1	219.63	25.65	313.03	8.59	3.57
D ₃ -13 th						
November	6.02	217.4	25.05	309.72	8.22	3.2
SEm±	0.002	0.027	0.015	0.047	0.009	0.011
C.D at 5 %	0.005	0.078	0.045	0.138	0.026	0.033

CONCLUSION

Thus, application of lime@100% LR with RDF and sowing on 15th October was found to be beneficial for maximizing the yield of sunflower , improvement of quality , uptake of nutrients by sunflower and fertility status of acid soil.

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