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RESEARCH PAPER

Effect of dolomite on productivity of groundnut and soil properties in alfisols

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Abstract: A field experiment was conducted at Main Agricultural Research Station, UAS, Dharwad, Karnataka, under rainfed conditions during *kharif* 2019. The experiment was laid out in randomized complete block design consisting of eight treatments (Control, Gypsum @ 500 kg ha^{-1}, Dolomite @ 250 kg ha^{-1}, Dolomite @ 500 kg ha^{-1}, Dolomite @ 750 kg ha^{-1}, Cured dolomite with FYM at the rate of 250 kg ha^{-1}, Cured dolomite with FYM @ 500 kg ha^{-1}, Cured dolomite with FYM @ 750 kg ha^{-1}) and replicated thrice. The results of the experiment showed that application of cured dolomite with FYM at the rate of 750 kg ha^{-1} recorded significantly higher kernel yield (1,984 kg ha^{-1}), which was 31.7 per cent higher than the control (1,506 kg ha^{-1}) and numerically higher pod yield (2,689 kg ha^{-1}) which was 20.2 per cent higher than the control (2,237 kg ha^{-1}) and found on par with the application of cured dolomite with FYM at the rate of 500 kg ha^{-1}, dolomite at the rate of 750 kg ha^{-1}and dolomite at the rate of 500 kg ha^{-1}. Higher pH (6.41) and EC (0.237 dS m^{-1}) were recorded with application of dolomite at the rate of 750 kg ha^{-1}, whereas significantly higher exchangeable calcium and magnesium content in the soil after harvest of groundnut (1.61 and 1.17 (cmol (p^{+}) kg^{-1}) were recorded with the application of cured dolomite with FYM at the rate of 750 kg ha^{-1}.

Key words: Calcium, Chemical properties, Dolomite, Groundnut

Introduction

India is one of the largest producer of oilseeds in the world and oilseed production occupies an important position in the Indian agricultural economy. Among oilseed crops, groundnut is an important and supplementary food crop of the world. Groundnut is the 13th most important food crop, third most important source of vegetable protein and fourth most important source of vegetable oil in the world. Almost every part of groundnut has commercial value, 80 per cent of its production is used for oil extraction, 12 per cent for seed, 6 per cent for edible purpose and 2 per cent for export purpose. Groundnut kernels contain 42 to 50 per cent oil, 26 per cent protein, 18 per cent carbohydrates, 11.5 per cent starch, 4.5 per cent soluble sugar, 2.1 per cent crude fiber and is also rich source of riboflavin, thiamine, nicotinic acid and vitamin E (Naresha *et al.,* 2018). It's a dietary source of calcium, iron, zinc, magnesium, phosphorus and potash. Its high protein, unsaturated fats, carbohydrates, vitamins and mineral contents makes it an important dietary component in many countries. Groundnut cake contains on an average 7 to 8 per cent N, 1.5 per cent P, 1.2 per cent K, 22 to 30 per cent carbohydrates, 45 to 60 per cent proteins, 4.0 to 5.7 per cent minerals and 3.8 to 7.5 per cent crude fibre (Bairagi *et al.,* 2017).

Groundnut is being commercially grown between 40° N and 40° S latitude. Globally, the crop is cultivated in an area of 26.4 million hectares with a total production of 37.1 m t and the average productivity is 1,400 kg ha^{-1}. The annual global export of groundnut is of 2 m t, with an annual all season coverage of about 70 lakh hectares. China and India are the world's leading groundnut producers, together accounting for nearly 60 per cent of the production and 52 per cent area (Anon., 2019).

In India groundnut is grown in an area of 4.73 m ha with a total production of 6.72 m t and productivity of 1,422 kg ha^{-1}. Gujarat stands first in area with 1.59 m ha and production with 2.20 m t and productivity of 1,382 kg ha^{-1}. With 3,199 kg ha^{-1} Puducherry stands first in productivity followed by West Bengal (2,788 kg ha^{-1}) and Tamil Nadu (2,718 kg ha^{-1}). In Karnataka groundnut is cultivated in 0.51 million hectares area with 0.39 million tonnes production and 759 kg ha^{-1} (Anon., 2019). Gujarat tops with 27.87 per cent of total production followed by Andhra Pradesh 24.19 per cent, Tamil Nadu 14.84 per cent and Karnataka 10.95 per cent. Maharashtra, Madhya Pradesh, Rajasthan, Odisha, Uttar Pradesh and West Bengal are other groundnut producing states (Anon., 2019).

Although groundnut is a self-fertilizing crop on the other hand it is very exhaustive as compared to other legumes. The balanced application of nutrients is the key to optimize the production of groundnut (Varade and Urkude, 1982). Groundnut seed development is unique from other plants. Once flowers are pollinated, a peg is formed which moves downward as geotropic movement and then moves horizontally called dia-geotropic movement. Calcium is the most critical element in growth and development of groundnut pegs, pods and seeds and is the main limiting factor of groundnut production in many parts of the country (Safarzadeh Vishkaee, 2004). For groundnut about 1 milli equivalent of exchangeable Ca 100 g^{-1} of soil in the root zone and three times this much in the pod formation zone are considered as threshold levels. So, it is very important that adequate levels of calcium should be present in the top 10-15 cm of soil, or pegging zone (Sumner *et al*. 1988) because that is the zone where developing pods must acquire calcium.

Calcium deficiency leads to higher percentage of aborted seeds (empty pods) and unfilled or partially filled pods called pops (Ntare *et al.,* 2008). It also leads to shrivelled fruit, including darkened plumules and production of pods without seed. Presence of enough calcium content in the soil prevents formation of black hallow and cracked pods, decreases aflatoxin production and consequently decreases decayed pod of groundnut (Habib, 2014).

Dolomite ($CaCO_3$. $MgCO_3$) is a double carbonate salt, having an alternate structural arrangement of calcium and magnesium ions. It has 21.73 per cent calcium, 13.18 per cent magnesium. Dolomite is widely used superior high calcium lime that increase soil pH and soil calcium levels (Rogers, 1948; Sullivan *et al*., 1974; Yang, 2015). It improves the physical, chemical and biological conditions of the soil, neutralizes the soil acidity and cuts fertilizer cost through improved fertilizer use efficiency. Dolomitic lime addition is needed to increase the availability of calcium and magnesium as well as to increase the concentration of basic cations like potassium, calcium and magnesium (Barchia, 2006).

Groundnut is most widely grown oilseed crop in peninsular India and some areas under coastal ecosystem shows formation of acidic soils particularly, in coastal Tamil Nadu, Kerala, Karnataka and Goa (Maji *et al.,* 2012). Nearly, one lakh hectares in the sea coast of India (east and west coast) represents such groundnut area. Keeping all the above points in view the present study was conducted in acidic soils to investigate the effect of dolomite on productivity of groundnut and soil properties in *Alfisols.*

Material and methods

A Field experiment to assess the Effect of dolomite on productivity of groundnut and soil properties in *alfisols* was conducted at Main Agricultural Research Station, UAS, Dharwad, Karnataka, under rainfed conditions during *kharif* 2019 on red sandy loam soils having low organic carbon (4.5 mg kg^{-1}), pH (6.34), Electrical conductivity (0.21 dS m^{-1}), exchangeable calcium (1.31cmol (p^+) kg^{-1}), exchangeable magnesium (0.87cmol (p^+) kg^{-1}), available nitrogen (276.5 kg ha^{-1}) and medium available phosphorus (18.6 kg ha^{-1}) and potassium (196.2 kg ha^{-1}) and acidic in reaction.

The experiment was laid out in randomized complete block design with eight treatments: T_1: Control, T_2: Gypsum @ 500 kg ha^{-1}, T_3: Dolomite @ 250 kg ha^{-1}, T_4: Dolomite @ 500 kg ha^{-1}, T_5: Dolomite @ 750 kg ha^{-1}, T_6: Cured dolomite with FYM @ 250 kg ha^{-1}, T_7: Cured dolomite with FYM @ 500 kg ha^{-1}, T_8: Cured dolomite with FYM @ 750 kg ha^{-1} replicated thrice. Groundnut variety G2-52 was sown on 17th July 2019 with a spacing of 30 × 10 cm. Recommended dose of N: P_2O_5: K_2O (18:46:25 kg ha^{-1}) and FYM @ 7.50 t ha^{-1} was applied uniformly to all the treatments at the time of sowing as a basal dose. Mean maximum and minimum temperatures were 31.5°C and 21.5°C, respectively and 1133 mm rainfall was received in 58 rainy days during the crop growing period.

Curing

Curing of dolomite with FYM in 1:2 proportion (Dolomite : FYM) was done prior to application and incubated for 15 days in air tight bag. At pegging stage (45 DAS) cured dolomite, dolomite and gypsum were applied to the crop according to the treatments. The FYM required for curing dolomite in T_6, T_7, T_8 was compensated in the basal dose of FYM. Harvesting of crop was done on 6th November, 2019.

Yield attributes and yield of crop was recorded at harvest and chemical properties of soil were analysed after harvest of the crop. Oil content was estimated after air drying of the kernels.

Statistical analysis

Interpretation of the data was carried out in accordance with Gomez and Gomez (1984). The level of significance used in the 'F' and 't' test was p=0.05. The critical difference values were calculated wherever the 'F' test values were significant. The treatment means were compared by applying Duncan's Multiple Range Test (DMRT) by using statistical software MSTAT-C.

Results and discussion

Effect of dolomite on yield and yield parameters

The data pertaining to yield attributes was presented in the Table (1). Significantly higher number of pods per plant (14.4), pod weight per plant (14.5 g $plant^{-1}$), 100 kernel weight (39.9 g) and significantly lower percentage of pops per plant (7.8 %)

Table 1. Yield attributes of groundnut as influenced by application of dolomite

Treatment	No. of pods per plant	Pod weight (g $plant^{-1}$)	Pops (%)	100 kernel weight (g)
T_1: Control (No gypsum and dolomite)	9.7^{b}	9.4^{b}	12.4^{a}	31.9^{b}
T_2: Gypsum at the rate of 500 kg ha^{-1}	13.4^{a}	13.3^{a}	9.4^{bcd}	37.6^{ab}
T_3: Dolomite at the rate of 250 kg ha^{-1}	13.1^{a}	13.2^{ab}	11.1^{ab}	36.2^{ab}
T_4: Dolomite at the rate of 500 kg ha^{-1}	13.6^{a}	13.7^{a}	9.2^{bcd}	37.7^{ab}
T_5: Dolomite at the rate of 750 kg ha^{-1}	13.8^{a}	13.9^{a}	8.8^{cd}	38.1^{ab}
T_6: Cured dolomite with FYM at the rate of 250 kg ha^{-1}	13.4^{a}	13.3^{a}	10.7^{abc}	35.6^{ab}
T_7: Cured dolomite with FYM at the rate of 500 kg ha^{-1}	14.1^{a}	14.4^{a}	8.4^{d}	39.4^{a}
T_8: Cured dolomite with FYM at the rate of 750 kg ha^{-1}	14.4^{a}	14.5^{a}	7.8^{d}	39.9^{a}
S.Em. ±	0.94	0.78	0.92	2.88
CV (%)	8.76	7.31	11.67	9.54

were recorded with application of cured dolomite with FYM at the rate of 750 kg ha^{-1}, which was found to be on par with the application of cured dolomite with FYM at the rate of 500 kg ha^{-1}, dolomite at the rate of 750 kg ha^{-1} and dolomite at the rate of 500 kg ha^{-1} whereas the lower value was recorded in the control. The difference in yield parameters among the treatments could be due to variation in the translocation of photosynthates from the vegetative parts to reproductive parts and increased growth parameters like leaf area, leaf area index and other growth parameters. This could be due to the fact that curing of dolomite with FYM would have facilitated better release of nutrients from the dolomite and additional availability of nutrients from organic source (FYM) which could have facilitated the better uptake of nutrients by the crop leading to increased yield attributes of the crop. These results are in line with the findings of Naresha *et al.* (2018).

The data related to yield of groundnut was presented in Table (2). Pod yield and haulm yield of groundnut was found non-significant with application of dolomite, whereas kernel yield was found to be significant. Higher pod yield (2,689 kg ha^{-1}), haulm yield (4,192 kg ha^{-1}) and significantly higher kernel yield (1,984 kg ha^{-1}) was recorded with the application of cured dolomite with FYM at the rate of 750 kg ha^{-1} and it was found on par with application of cured dolomite with FYM at the rate of 500 kg ha^{-1}, dolomite at the rate of 750 kg ha ^{1} and dolomite at the rate of 500 kg ha^{-1}. Though there is no significant impact of dolomite on pod yield of groundnut, increasing trend in yield was noticed from 250 to 750 kg ha^{-1}. Even though pod yield of groundnut was found to be non significant, there is a significant difference among treatments with respect to kernel yield of groundnut. This could be due to lower pops percentage, higher pod weight per plant, higher shelling percentage, and higher 100 kernel weight as compared to other treatments. Dolomite is an ameliorant which supplies calcium and magnesium nutrients to the crop which are important for gynophore formation and filling of pods. The increased yield in the cured dolomite application treatment (T_8) could be due to availability of sufficient amount of calcium in the pod zone of crop at critical period of calcium requirement which resulted in reduced pops percentage (4.6 % reduction as compared to control). Besides supplying calcium and magnesium, application of dolomite also increased soil pH. With increasing soil pH, availability of nutrients increases especially phosphorus which is fixed in the soil as aluminium or iron phosphate and hence better performance of the crop (Seopardi, 1983). The additional effect noticed due to curing of dolomite with FYM was the better release and availability of nutrients and reduced losses of nutrients by different mechanisms from the dolomite as compared to the treatment in which dolomite was applied without curing and other treatments. These results are in line with the findings of Sutriadi and Setyorini (2012), Kumar *et al.* (2016).

The lower pod yield and kernel yield of groundnut were recorded in the control treatment (2,237 kg ha^{-1}) in which no dolomite and gypsum were applied as shown in the Table (2). The decreased yield could be due to the fact that calcium was not available to the crop during the flowering stage which lead to decreased percentage of filled pods and increased pops percentage. The results are in conformity with the findings of Kamara *et al.* (2011), Agasimani and Hosmani (1990).

The increased haulm yield due to application of cured dolomite could be due to increased vegetative growth and total dry matter production and its accumulation in different parts of the plant. The increased growth parameters like leaf area and dry matter production due to application of cured dolomite might have contributed to the increased haulm yield of groundnut. Similar findings were reported by Kabir *et al.* (2013).

Higher oil content was (47.94 %) was recorded with the application of gypsum at the rate of 500 kg ha^{-1} and it was found to be on par with dolomite application treatments. Whereas, lower oil content was recorded in the control. Higher oil content recorded due to application of gypsum could be due to the fact that gypsum being a source of sulphur along with calcium, enhances the oil content of kernels. The increased oil content due to application of dolomite as compared to the control treatment might be due to the additive effect of calcium present in the dolomite which resulted in sound mature kernels leading to attainment of higher oil content. Significantly higher oil yield (889 kg ha^{-1}) was recorded with the application of gypsum at the rate of 500 kg ha^{-1} and it was found on par with application of cured dolomite with FYM at the rate of 750 kg ha^{-1}

Table 2. Pod yield, kernel yield, haulm yield, oil content and oil yield of groundnut as influenced by application of dolomite

Treatment	Dry pod yield (kg ha^{-1})	Kernel yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Oil content (%)	Oil yield (kg ha^{-1})
T_1: Control (No gypsum and dolomite)	2237^{a}	1506^{b}	3448^{a}	41.77^{b}	627^{b}
T_2: Gypsum at the rate of 500 kg ha^{-1}	2574^{a}	1862^{ab}	4011^{a}	47.94^{a}	889^{a}
T_3: Dolomite at the rate of 250 kg ha^{-1}	2429^{a}	1715^{ab}	3757^{a}	42.38^{b}	727^{ab}
T_4: Dolomite at the rate of 500 kg ha^{-1}	2613^{a}	1933^{a}	4144^{a}	44.30^{ab}	859^{a}
T_5: Dolomite at the rate of 750 kg ha^{-1}	2635^{a}	1918^{a}	4092^{a}	44.78^{ab}	860^{a}
T_6: Cured dolomite with FYM at the rate of 250 kg ha^{-1}	2566^{a}	1848^{ab}	3928^{a}	43.51^{ab}	809^{ab}
T_7: Cured dolomite with FYM at the rate of 500 kg ha^{-1}	2651^{a}	1960^{a}	4129^{a}	44.77^{ab}	881^{a}
T_8: Cured dolomite with FYM at the rate of 750 kg ha^{-1}	2689^{a}	1984^{a}	4192^{a}	45.16^{ab}	888^{a}
S.Em. ±	203.2	145.8	308.48	2.15	83.97
CV (%)	9.77	9.67	9.53	6.36	9.20

Table 3. Chemical properties of soil after harvest of groundnut as influenced by application of dolomite

Treatment	pH	EC (ds m^{-1})	Organic carbon (g kg^{-1})	Ca (cmol (p^+) kg^{-1})	Mg (cmol (p^+) kg^{-1})
T_1: Control (No gypsum and dolomite)	6.33^a	0.207^a	4.6^a	1.09^b	0.81^e
T_2: Gypsum at the rate of 500 kg ha^{-1}	6.30^a	0.213^a	4.8^a	1.54^a	0.83^{de}
T_3: Dolomite at the rate of 250 kg ha^{-1}	6.36^a	0.220^a	4.7^a	1.46^a	0.93^{cde}
T_4: Dolomite at the rate of 500 kg ha^{-1}	6.38^a	0.237^a	5.1^a	1.55^a	0.98^{bc}
T_5: Dolomite at the rate of 750 kg ha^{-1}	6.41^a	0.237^a	5.2^a	1.58^a	1.08^{ab}
T_6: Cured dolomite with FYM at the rate of 250 kg ha^{-1}	6.35^a	0.217^a	4.9^a	1.48^a	0.96^{bcd}
T_7: Cured dolomite with FYM at the rate of 500 kg ha^{-1}	6.37^a	0.223^a	5.3^a	1.59^a	1.05^{abc}
T_8: Cured dolomite with FYM at the rate of 750 kg ha^{-1}	6.39^a	0.230^a	5.6^a	1.61^a	1.17^a
Initial	6.34	0.21	4.5	1.31	0.87
S.Em. ±	0.517	0.0164	0.37	0.119	0.089
CV (%)	9.96	9.04	9.12	8.11	7.64

(888 kg ha^{-1}), cured dolomite with FYM at the rate of 500 kg ha^{-1}, dolomite at the rate of 750 kg ha^{-1}, dolomite at the rate of 500 kg ha^{-1}, whereas lower oil yield (627 kg ha^{-1}) was recorded in control. Higher oil yield attained could be due to higher kernel yield, 100 kernel weight and oil content. The results are in conformity with the findings of Rao *et al.* (2013).

Effect of dolomite on soil chemical properties

Soil chemical properties *viz.,* pH, EC and OC content of soil did not varied significantly due to application of dolomite as shown in the Table 3. However, increasing trend was observed from 250 to 750 kg ha^{-1} of dolomite application. Higher pH (6.41) and EC (0.237 dS m^{-1}) were recorded with application of dolomite at the rate of 750 kg ha^{-1} and it was on par with the application of dolomite at the rate of 500 kg ha^{-1} whereas higher organic carbon (5.6 mg kg^{-1}) content in soil after harvest of groundnut was recorded with application of cured dolomite with FYM @ 750 kg ha^{-1}. Significantly higher exchangeable calcium and magnesium content in the soil (1.61 and 1.17 cmol (p^+) kg^{-1}), respectively were recorded with the application of cured dolomite with FYM at the rate of 750 kg ha^{-1} which was on par with the application of cured dolomite with FYM at the rate of 500 kg ha^{-1}, dolomite at the rate of 750 kg ha^{-1} and dolomite at the rate of 500 kg ha^{-1}. This could be due to the fact that with increasing the dose of dolomite, calcium and magnesium bases addition will increase in the soil further more they substitute aluminium in the soil leading to increase in the pH. These results are in line with the findings of Sutriadi and Setyorini (2012), Murata (2003).

Conclusion

The results of the experiment clearly indicated that dolomite can be applied to the groundnut which enhances the productivity of groundnut similar to gypsum in acidic soils. The progressive increase observed with dolomite application between 500 to 750 kg ha^{-1} was tiny as compared to progressive increase observed between 250 to 500 kg ha^{-1}. It clearly indicated that groundnut responded up to 500 kg ha^{-1} either with or without curing of dolomite and thereafter law of diminishing marginal returns has been observed i.e., adding additional factor of production (dolomite) would actually resulted in smaller increases in output (yield) and similar difference existed between cured and un-cured treatments. In addition, looking to the bulky nature of the dolomite for transport, it was found that application of dolomite @ 500 kg ha^{-1} was better to obtain higher pod yield and net returns besides improving soil chemical properties.

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