Effect of granulated lime and bio-inoculants on the productivity of French bean (*Phaseolus vulgaris* L.) under hilly zone of Karnataka

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Abstract

A field experiment was conducted at College of Horticulture, Mudigere, Chikamagalur district, Karnataka to investigate the effect of granulated lime and bio-inoculants on the productivity of French beans (*Phaseolus vulgaris* L.) under the hilly zone of Karnataka during late *rabi* season 2019-20. The experiment was laid out in RCBD with nine treatments replicated thrice. The treatments consisted of granulated lime at three levels (100, 75 and 50 % LR) and agriculture lime at 100 % LR, with and without bio-inoculants. RDF and FYM were common to all treatments. The liming materials were applied based on SMP (Shoemaker, Mclean and Pratt) buffer method. The results revealed that significantly higher plant height (51.1 cm), number of branches (6.88 plant*−1*), number of leaves (26.42 plant*−1*), chlorophyll content (49.64 SPAD) and dry matter accumulation (19.34 g plant*−1*) were achieved in the treatment with 100 % LR of granulated lime. The bio-inoculants, *Rhizobium* and *Azotobacter* along with 100 % LR of granulated lime significantly increased green pod yield (12.93 t ha*−1*), number of leaves (26.42), pod length (15.67 cm), pod weight (177.17 g plant*−1*), green pod yield (12.93 t ha*−1*) and stover yield (2.93 t ha*−1*) over control.

Keywords: Agriculture lime, Bio-inoculants, French bean, Granulated lime, Growth and Yield

Introduction

French bean (*Phaseolus vulgaris* L.), also known as a green bean or common bean, is an annual herbaceous plant family Fabaceae. Bean are called "meat of the poor", contribute essential protein to the undernourished people. It is cultivated worldwide and contributes nearly 30 per cent of food legumes total production (Vasishtha and Srivastava, 2012). In India, green beans are cultivated over 0.24 mha with a production of 0.67 m t and 27,940 kg ha*−1* productivity. The dry beans are cultivated in an area of 15.42 m ha with a production of 6.39 m t and 4,142 kg ha*−1* productivity. In Karnataka, it is grown on an area of 15.699 m ha with a total production of 16,785 tonnes and productivity of 11 t ha*−1* (Anon., 2017). It is rich It is a rich source of nutrient and minerals viz., protein content 17.5 to 28.7 per cent in dry seeds and 1.0 to 2.5 per cent in green pods, 3.2 to 5.0 per cent mineral matter, 4.2 to 6.3 per cent crude fiber, 1.2 to 2.0 per cent crude fat and 340 to 450 K cal energy, 0.16 mg iron, 1.76 mg calcium and 3.43 mg zinc per 100 g of the edible part (Sardana et al., 2000) [6] and has many other medicinal uses.

In India, approximately one-third of the cultivated land is affected by soil acidity. The majority of these soils are concentrated in India's northeastern region, with nearly 65 per cent of its area being under extreme forms of soil acidity with pH below 5.5. (Sharma and Singh, 2002) [7]. Out of the 19.2 m ha of the geographical area in Karnataka, nearly 9.6 m ha (50 per cent of the total area) is acidic spanning spanning across the districts of Dakshina Kannada (72 %), Uttara Kannada (65 %), Kodagu (40 %), Chickmagalur (39 %), Shivamogga (33 %), Hassan (20 %), Mysore (15 %), Mandya (12 %), Bangalore (10 %) and Belgaum (10 %) (Ananthanarayana, 1996) [1].

It creates unfavourable environment in the soil due to iron and aluminium toxicity and reduced microbial activity, thereby the productivity of crops grown on acid soils are reduced. Applying liming materials is the best management practice to reclaim acid soils. Granulated lime is an agglomeration of very finely ground and or micronized particles of calcium or magnesium
carbonate (limestone) with at least 90 per cent passing a 150-
micron sieve with binders like clay and lignosulfonates added
to the powder to make it granules.

Keeping these things in view the experiment was conducted
to know the effect of granulated lime and bio-inoculants on
t at French bean.

Material and Methods
A field experiment was conducted during late rabi season of-
2019 at College of Horticulture, Mudigere, UAHS, Shimogga which is situated in the Hilly Zone (Zone-9) of
Karnataka. The geographical reference point of the experimental site was 13° 7' North latitude and 74° 37' East
longitude and at an altitude of 980 m above the mean sea
level. The soil was sandy loam in texture, highly acidic pH
(4.52) and low in electrical conductivity (0.033 dS m⁻²),
medium organic carbon 0.58 % and medium in available
nitrogen and phosphorus (288.68 and 31.88 kg ha⁻¹,
respectively), and low in potassium status (98.73 kg K₂O ha⁻¹).
During the experiment period, the total actual rainfall
received was 419.90 mm.

Field experiment was laid out in randomized complete block
design with nine treatments and three replications. Treatments consisted of agriculture (powder lime), different levels of
granulated lime with or without bio-inoculants (Azotobacter,
PSB, KSB) viz., T₁: RDF + FYM (control), T₂: T₁ +
agriculture lime @ 100% LR, T₃: T₁ + agriculture lime @
100% LR + bio-inoculants, T₄: T₁ + granulated lime @ 100% LR,
T₅: T₁ + granulated lime @ 75% LR, T₆: T₁ + granulated lime @
50% LR, T₇: T₁ + granulated lime @ 100% LR + bio-
inoculants and T₈: T₁ + granulated lime @ 75% LR + bio-
inoculants, T₉: T₁ + granulated lime @ 50% LR + bio-
inoculants. The lime requirement for experimental site was
measured by SMP buffer method (Shoemaker et al., 1961)
and granulated lime (dolomite) was applied based on calcium
carbonate equivalent (CCE) value. The lime requirement (LR)
was found to be 16.25 t ha⁻¹. The variety used is Arjun,
developed by United Genetics India Private Limited. Bio-
inoculants were mixed with farm yard manure at the rate of
650 ml ha⁻¹, incorporated into soil and the liming materials
were spread (broadcasted) on the soil surface as per
treatments. The liming materials and FYM were applied in the
month of November. All the biometric observations recorded
were subjected to analysis.

Results and Discussion
Effect of granulated lime and bio-inoculants on the growth
and development of French bean
Significantly higher growth parameters were recorded in the
treatment received T₁+ granulated lime @ 100% LR + bio-
inoculants (T₇) compared to control at 20, 40 DAS and at
harvest.

The plant height progressively increased with advancement in
the age of crop, significantly higher plant height (17.87, 46.36
and 51.18 cm was recorded at 20, 40 DAS and at harvest,
respectively). This increase in plant height in french bean
might be due to favourable soil condition created by the
application of lime, FYM and bio-inoculants and the reduced
harfeful effect of iron and aluminum in the soil. These
findings are in line with the Dinesh Varma et al. (2017) and
Mohanthy et al. (2017) [5].

Like tillering in cereals, branching is an important growth
parameter in pulse crops like french bean. The number of
branches per plant determines the yield parameters like
number of flowers per plant and number of pods per plant.

Significantly maximum number of branches (1.07, 6.48 and
6.88 plant⁻¹ at 20, 40 DAS and at harvest, respectively) and
highest number of leaves plant⁻¹ (6.63, 26.22 and 26.42 plant⁻¹
at 20, 40 DAS and at harvest, respectively) was noticed in the
treatment T₇. The availability of nutrients at initial stages of
crop growth due to the action of lime, FYM, biological
nitrogen fixation and phosphorous and potassium
solubilisation by the bio-inoculants, improved rate of
photosynthesis and translocation of photosynthates could have
helped in obtaining higher number of branches and leaves per
plant.

The liming materials and bio-inoculants significantly
influence the chlorophyll content in the leaves. The highest
chlorophyll (SPAD) was recorded with the application of
100% RDF + FYM + granulated lime @ 100% LR + bio-
inoculants (T₇) at 20, 40 DAS and at harvest (38.47, 56.58
and 49.64, respectively). The chlorophyll content was
relatively higher in granulated lime treatments than
agriculture lime treatments due to its higher magnesium
content. This improved the photosynthetic activity of the
leaves. Similar observations were made by Tupaki et al.
(2017) [10] and Bhindhu et al. (2018) [3].

Total dry matter (TDM) accumulation is a significant index
representing the plant's growth and metabolic efficiency which
ultimately influences crop yield. The amount of TDM
produced indicates the overall efficiency of resource
utilisation and better interception of light. Significantly higher
total dry matter production (2.64, 7.34 and 19.34 g plant⁻¹
at 20, 40 DAS and at harvest, respectively) were produced in the
treatment T₇. The increase in plant height, number of leaves
and number of branches per plant resulted in greater total
dry matter accumulation. The improvement in chlorophyll content
and photosynthetic leaf area might have led to better
interception, absorption and utilization of solar energy,
leading to a higher photosynthetic rate and finally higher
production and accumulation of photosynthates. The increase
in the nutrient uptake due to lime and bio-inoculants' action
might have also helped maintain a higher auxin content level,
which might have resulted in better plant height, number of
leaves, and leaf area of the crop.

Effect of granulated lime and bio-inoculants on the yield
parameters and yield of French bean
The green pod yield is governed by number of factors which have
direct or indirect impacts. It can be enhanced by
improving the yield attributing characters viz., number of pods
per plant, pod weight per plant and pod length.

In the present investigation, application of RDF + FYM +
granulated lime @ 100% LR + bio-inoculants increased the
growth and yield attributing characters and it may be due to
the greater assimilatory leaf area as it is a major source for
supplying assimilates to the developing pods. Significantly
higher number of pods plant⁻¹ (21.43), pod length (15.67 cm)
and pod weight (177.17 g plant⁻¹), followed by T₇ and T₉.
Similar results were observed by Sultana et al. (2019).
The increase in the number of branches increases the flowering
points and hence the number of pods per plant. The improved
photosynthetic activity led to efficient production and
translocation of photosynthates from source to sink this
reflects on the production of better yield attributing
parameters like pod length and weight. The green pod and
stover yield (12.93 and 2.93 t ha⁻¹) increased due to more
c number of pods per plant and heavier pods due to increased
accumulation of photosynthates. The use of bio-inoculants
helped in crop production by improving nutrient availability.
Conclusion

The application of RDF + FYM + granulated lime @ 100% LR + bio-inoculants increased the growth, yield parameters and yield (12.93 t ha$^{-1}$) of French bean under Hilly zone of Karnataka and helped in sustainable crop production. The granulated lime performed better than agriculture lime due to slow release, longer existence in soil, reduced leaching and runoff loss and higher magnesium content. It can be used as an alternate source to ameliorate soil acidity.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Plant height (cm)</th>
<th>No. of branches plant$^{-1}$</th>
<th>No. of leaves plant$^{-1}$</th>
<th>Chlorophyll content (SPAD)</th>
<th>Total dry matter (g plant$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20 DAS 40 DAS</td>
<td>At harvest</td>
<td>20 DAS 40 DAS</td>
<td>At harvest</td>
<td>20 DAS 40 DAS At harvest</td>
</tr>
<tr>
<td>T$_1$</td>
<td>14.61 34.84</td>
<td>38.47 1.08 4.97 5.27</td>
<td>5.30 16.44 17.76</td>
<td>34.38 47.07 39.14</td>
<td>2.44 4.23 11.09</td>
</tr>
<tr>
<td>T$_2$</td>
<td>17.19 41.84</td>
<td>46.03 1.01 5.88 6.21</td>
<td>5.77 21.93 22.85</td>
<td>34.91 49.92 43.39</td>
<td>2.51 6.41 17.26</td>
</tr>
<tr>
<td>T$_3$</td>
<td>17.66 20.88</td>
<td>50.47 1.05 6.47 6.76</td>
<td>6.27 25.52 25.85</td>
<td>35.09 50.18 43.62</td>
<td>2.57 7.19 18.76</td>
</tr>
<tr>
<td>T$_4$</td>
<td>17.22 42.17</td>
<td>46.39 1.02 6.12 6.44</td>
<td>5.90 22.32 24.18</td>
<td>37.29 54.29 47.32</td>
<td>2.52 6.73 18.95</td>
</tr>
<tr>
<td>T$_5$</td>
<td>16.97 41.57</td>
<td>20.91 1.05 5.57 5.82</td>
<td>5.70 21.81 22.50</td>
<td>36.06 51.56 44.86</td>
<td>2.49 6.20 16.77</td>
</tr>
<tr>
<td>T$_6$</td>
<td>16.11 39.10</td>
<td>43.01 1.04 5.19 5.51</td>
<td>5.48 18.40 19.93</td>
<td>35.12 50.42 43.82</td>
<td>2.43 5.63 14.09</td>
</tr>
<tr>
<td>T$_7$</td>
<td>17.87 46.36</td>
<td>51.18 1.07 6.48 6.88</td>
<td>6.63 26.22 26.42</td>
<td>38.47 56.58 49.64</td>
<td>2.64 7.33 19.34</td>
</tr>
<tr>
<td>T$_8$</td>
<td>17.38 44.68</td>
<td>49.15 1.03 6.36 6.64</td>
<td>6.00 25.49 25.61</td>
<td>36.48 53.26 46.32</td>
<td>2.55 7.01 18.25</td>
</tr>
<tr>
<td>T$_9$</td>
<td>16.81 41.18</td>
<td>44.86 1.08 5.39 5.75</td>
<td>5.59 19.15 21.02</td>
<td>35.64 51.32 44.36</td>
<td>2.47 5.76 14.39</td>
</tr>
<tr>
<td>S. Em ±</td>
<td>0.98 2.42</td>
<td>2.51 0.01 0.24 0.32</td>
<td>0.98 2.42 2.51</td>
<td>0.71 1.43 1.79</td>
<td>0.03 0.79 2.02</td>
</tr>
<tr>
<td>CD @ 5%</td>
<td>2.91 7.26</td>
<td>7.47 0.74 0.96</td>
<td>NS</td>
<td>NS</td>
<td>2.11 4.27 5.35</td>
</tr>
</tbody>
</table>

Table 1: Effect of granulated lime and bio-inoculants on growth parameters of French bean

<table>
<thead>
<tr>
<th>Treatment details</th>
<th>no. of pods (plant$^{-1}$)</th>
<th>pod length (cm)</th>
<th>pod weight (g plant$^{-1}$)</th>
<th>Green pod yield (t ha$^{-1}$)</th>
<th>Stover yield (t ha$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T$_1$: RDF + FYM</td>
<td>15.88 10.96</td>
<td>110.29</td>
<td>8.71</td>
<td>2.52</td>
<td></td>
</tr>
<tr>
<td>T$_2$: T$_1$ + agriculture lime @ 100% LR</td>
<td>19.23 13.92</td>
<td>160.64</td>
<td>11.79</td>
<td>2.64</td>
<td></td>
</tr>
<tr>
<td>T$_3$: T$_1$ + agriculture lime @ 100% LR + bio-inoculants</td>
<td>20.43 15.39</td>
<td>173.48</td>
<td>12.87</td>
<td>2.86</td>
<td></td>
</tr>
<tr>
<td>T$_4$: T$_1$ + granulated lime @ 100% LR</td>
<td>19.84 14.19</td>
<td>165.29</td>
<td>12.11</td>
<td>2.67</td>
<td></td>
</tr>
<tr>
<td>T$_5$: T$_1$ + granulated lime @ 75% LR</td>
<td>18.52 13.66</td>
<td>157.78</td>
<td>11.58</td>
<td>2.57</td>
<td></td>
</tr>
<tr>
<td>T$_6$: T$_1$ + granulated lime @ 50% LR</td>
<td>17.19 13.25</td>
<td>140.97</td>
<td>10.33</td>
<td>2.43</td>
<td></td>
</tr>
<tr>
<td>T$_7$: T$_1$ + granulated lime @ 100% LR + bio-inoculants</td>
<td>21.43 15.67</td>
<td>177.17</td>
<td>12.93</td>
<td>2.93</td>
<td></td>
</tr>
<tr>
<td>T$_8$: T$_1$ + granulated lime @ 75% LR + bio-inoculants</td>
<td>20.24 15.09</td>
<td>169.19</td>
<td>12.44</td>
<td>2.74</td>
<td></td>
</tr>
<tr>
<td>T$_9$: T$_1$ + granulated lime @ 50% LR + bio-inoculants</td>
<td>18.35 13.57</td>
<td>151.22</td>
<td>10.57</td>
<td>2.51</td>
<td></td>
</tr>
<tr>
<td>S. Em ±</td>
<td>1.10 1.11</td>
<td>17.53</td>
<td>1.28</td>
<td>0.09</td>
<td></td>
</tr>
<tr>
<td>C. D. at 5%</td>
<td>3.30 3.31</td>
<td>52.22</td>
<td>3.82</td>
<td>0.27</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Effect of granulated lime and bio-inoculants on yield and yield parameters of French bean

References


RDF @ 63:100:75 N:P:O$_5$:K$_2$O FYM @ 25 t ha$^{-1}$.