Identification of promising Lentil genotypes for Terai region of West Bengal

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ABSTRACT

The present investigation was carried out during 2015 – 2017, where 22 lentil genotypes grown under bio inoculation treated and non treated conditions in multi location for two consecutive seasons, in order to identify bio inoculants responsive and suitable varieties. The trial was conducted in two district of West Bengal i.e. Malda and Coochbehar. The results indicated that genotypes responded differentially to bio inoculants. Six genotypes ILL-2-8, PL-406, Subrata, ILL-2-14, L-4076 and ILL-10951 performed well with higher inoculation efficiency. There was a positive relation between inoculation efficiency and change in harvest index due to bio inoculation and a negative relationship was found between percent incremental dry matter accumulated in the shoot and change in harvest index due to bio-inoculation. Five lentil genotypes which are responsive to bio inoculants were selected and its assessment was done in order to select the most suitable genotypes in specific environments. From the results, it was evident that significant differences were found among 5 lentil genotypes. In Coochbehar district the highest yield was recorded in K 75 (1.83t/ha). In Malda district, the same variety yielded significantly higher than all other varieties with 2.47 t/ha. Out of the selected varieties for multilocational trial, which performed better than the popular variety Maitree with a potential yield of 1.16 and 1.76 t/ha in Coochbehar and Malda tested under different projects, K-75 and BM-6 may be selected for further exploitation in the region with good adaptability and yield potential.

Key words: Bio inoculants, Environment, Germplasms, Lentil, Multilocational, Partitioning.

INTRODUCTION

Lentil (Lens esculenta M.) is an annual bushy herb, angular slender stem, almost erect or sub-erect, much-branched, softy hair and about 30-75 cm in height. The leaves are alternate, compound, pinnate usually ending in a tendril or bushy. It belongs to the sub-family Papilionaceae under the family Leguminosae. It is popular for its lens shaped seeds, which are consumed as food all over the world in stew or other forms for its protein, minerals (K, P, Fe, Zn) and vitamins, and because of its high lysine and tryptophane content, its consumption with wheat or rice provides a balance in essential amino acids for human nutrition (Bhatty, 1988). It originated from Turkey (Ladizinsky, 1979) and was introduced into the Indo-Gangetic plain around 2000 BC. Lentil ranks fifth position in terms of area and production but first for the consumer’s preference in India.

The crop is traditionally grown during the dry winter on residual soil moisture under rainfed condition and faces serious competition with wheat, oil seeds, potatoes and other important high value crops grown in winter months particularly during available irrigation. As a result the crop has been pushed to marginal and sub- marginal lands. Madhya Pradesh and Uttar Pradesh have maximum share in area (40.5%) and production (45.8%) respectively whereas West Bengal share on area and production are 4.0% and 4.2 % respectively. Due to its limited share and lack of bioinoculants responsive and location specific potential lentil variety, the production of Lentil is not enough to meet the demand of growing population.

Biofertilizer could be one of the most important factors that lead to increase in productivity significantly. Use of bio-inoculants in lentil cultivation helps to safeguard the soil health by avoiding use of synthetic fertilizer at the same time there is enhancement in quantity and quality of the crop. Venkateswarlu et al., (2007) observed that phosphate solubilizing bacteria have the potential to convert unavailable source of phosphorus like rock phosphate, aluminium phosphate, tricalcium phosphate etc into available form by releasing its metabolites like gluconic, succinic, citric, malic, fumaric and glyoxylic acids.

From long back since 1950s phosphate solubilizing bacteria (PSB) are used as biofertilizer. The Rhizobium as fertilizer in pulse crops could fix 50-200 Kg of N/ha at single cropping season and is able to substitute 80-90 % of nitrogen requirement of the crop. Plants perform differentially in different environmental condition due to its interaction with the environment. Researchers like Zilio et al., (2014) revealed that growing beans in multi location influence its grain quality. Therefore, the performance of different bean (Phaseolus vulgaris) genotypes under different locations

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helps in the identification of genotypes with increasing adaptability and performance in specific crop environment.

Unfortunately, there are few researches available in India on the effect of biofertilizer on lentil and also evaluation of new genotypes under different environments to interpret GE interaction. Keeping this concern in view, an attempt was made to determine the responsiveness of lentil genotypes to bio-inoculation and its multi locational trial in terai region and old alluvial zone of West Bengal

MATERIALS AND METHODS

The experiment was carried out during the winter season of 2015-2017 in Malda and Coochbehar district of West Bengal. It is situated in the foot hills of Eastern Himalayan, the average rainfall of this zone varies between 2100 to 3300 mm. The maximum rainfall i.e., about 80% of the total, is received from south-west monsoon during the rainy months of June to September. The temperature of this area varies from minimum of 7.1-8ºC to maximum of 24.8-32.2ºC. The area as a whole is humid and warm from May to Sept. And cool from Nov. to March. Lentil genotypes i.e. Subrata, ILL-10951, L-4076, ILL-10971, L III2-15, ILL-10897, DPL-62, ILL-10805, LIII2-8, LIII2-14, PL-406, WBL-81, ILL-237, Bari-Masur-5, KLS-218, ILL-10803, K-75, Hull-57, Bari Masur -7, Bari Masur-6 , PL-406, Hull-57 and BM-5 were collected from Lentil Project sponsored by ICARDA at Bidhan Chandra Krishi Viswavidyalaya. The experiment was laid out in randomized block design with two replications and two treatments covering an area of 70 sq m in each location at spacing of 20 cm from row to row. Seeds start emerges at 4-5 days after sowing. Intercultural operations were followed whenever needed. All the grown genotypes were harvested when most of the pods became mature (about 90% pods were brown) and different data were recorded and analyzed according to the purpose of the experiment.

Out of 22 Lentil genotypes 5 Lentil genotypes which were highly responsive to bio inoculants and performing best were further selected for multilocational trial. Selected 7 lentil genotypes were grown at different location i.e. in Bijoynagar, Chachal, Satmile and Pundibari by following the same procedure followed above. The data collected were analyzed by using statistical software MSTAT-C.

RESULTS AND DISCUSSION

The results indicate (Table-1) that significant change was found in shoot length between inoculated and non-inoculated plants of eight genotypes namely BM-6, ILL-2-8, DPL-62, Subrata, ILL-2-15, BM-7 and ILL-10951 whereas other entries like L-4076, ILL-10971, ILL-10897, ILL-2-14, PL-406, Hull-57 and BM-5 shows reduction in shoot length (cm) under bio inoculated condition (Plate-1).

| Germlasms  | Shoot length (cm) | Fresh shoot weight (g) | Dry Shoot weight (g) |
|------------|-------------------|------------------------|----------------------|
| Subrata    | 35.00             | 42.00                  | 10.04                |
| ILL-10951  | 34.00             | 38.80                  | 13.30                |
| L-4076     | 40.20             | 39.80                  | 12.82                |
| ILL-10971  | 26.70             | 25.70                  | 26.35                |
| L III2-15  | 32.00             | 38.40                  | 12.10                |
| ILL-10897  | 47.00             | 37.00                  | 13.65                |
| DPL-62     | 28.00             | 35.20                  | 6.01                 |
| ILL-10805  | 37.80             | 33.40                  | 10.08                |
| LIII2-8    | 30.80             | 40.00                  | 8.64                 |
| LIII2-14   | 33.60             | 31.00                  | 11.43                |
| PL-406     | 40.20             | 34.80                  | 10.96                |
| WBL81      | 41.60             | 43.00                  | 10.68                |
| ILL-237    | 37.60             | 34.00                  | 9.08                 |
| KLS-218    | 38.20             | 38.60                  | 10.37                |
| ILL-10803  | 33.00             | 34.00                  | 12.92                |
| K-75       | 39.20             | 42.80                  | 14.09                |
| Hull-57    | 42.00             | 39.00                  | 9.77                 |
| BM-5       | 37.40             | 37.20                  | 10.09                |
| BM-7       | 32.00             | 37.60                  | 7.33                 |
| BM-6       | 29.20             | 39.00                  | 7.77                 |
| PL-6       | 34.60             | 36.80                  | 8.60                 |
| PL-7       | 43.40             | 39.60                  | 11.18                |
| Maitry     | 37.80             | 35.00                  | 9.75                 |
| CD .05     | 1.54              | 1.75                   | 0.48                 |
| SEM ±      | 4.51              | 5.14                   | 1.42                 |

NT – Not treated, T – Treated
Plate 1: Responsiveness of lentil genotypes to bio inoculation.

| Germplasms    | Root Length (cm) NT | Root Length (cm) T | Dry root weight (g) NT | Dry root weight (g) T | Inoculation efficiency% |
|---------------|---------------------|-------------------|------------------------|-----------------------|-------------------------|
| Subrata       | 6.90                | 7.40              | 0.25                   | 0.28                  | 6.76                    |
| ILL-10951     | 7.40                | 7.20              | 0.27                   | 0.38                  | 19.05                   |
| L-4076        | 6.80                | 8.40              | 0.38                   | 0.42                  | 8.33                    |
| ILL-10971     | 7.70                | 8.40              | 0.28                   | 0.32                  | -6.12                   |
| L III2-15     | 7.80                | 7.35              | 0.27                   | 0.29                  | 1.99                    |
| ILL-10897     | 7.40                | 7.55              | 0.22                   | 0.32                  | 13.89                   |
| DPL-62        | 6.20                | 7.20              | 0.32                   | 0.32                  | -12.12                  |
| ILL-10805     | 7.40                | 6.60              | 0.32                   | 0.32                  | 16.67                   |
| LIII2-14      | 6.40                | 6.78              | 0.3                    | 0.38                  | -11.48                  |
| PL-406        | 6.45                | 6.40              | 0.23                   | 0.34                  | -0.78                   |
| WBL81         | 7.20                | 7.55              | 0.25                   | 0.28                  | 4.64                    |
| ILL-237       | 5.60                | 6.40              | 0.26                   | 0.33                  | 12.50                   |
| KLS-218       | 6.20                | 7.00              | 0.26                   | 0.31                  | 11.43                   |
| ILL-10803     | 7.00                | 6.80              | 0.3                    | 0.38                  | -2.94                   |
| K-75          | 7.00                | 7.60              | 0.29                   | 0.35                  | 7.89                    |
| Hull-57       | 5.60                | 6.40              | 0.25                   | 0.28                  | 12.50                   |
| BM-5          | 7.80                | 7.60              | 0.25                   | 0.33                  | -2.63                   |
| BM-7          | 6.10                | 6.60              | 0.23                   | 0.36                  | 7.58                    |
| BM-6          | 5.00                | 6.70              | 0.23                   | 0.46                  | 25.37                   |
| PL-6          | 5.20                | 7.00              | 0.23                   | 0.32                  | 25.71                   |
| PL-7          | 7.00                | 7.12              | 0.29                   | 0.32                  | 1.69                    |
| Maitry        | 6.10                | 6.50              | 0.2                    | 0.24                  | 6.15                    |
| CD            | 1.41                |                   | 0.07                   |                      |

Data presented in the Table-2 indicates that dry root weight (g) was recorded significant in all germplasms under bio-inoculated condition.

In case of root length 16 out of 22 germplasm showed positive inoculation response with highest in PL-6 followed by BM-6, L-4076, ILL-2-8 and DPL-62 and lowest in PL-7 followed by ILL-10897, WBL-81, Maitry and Subrata.
In case of dry root weight all 22 germplasm showed positive inoculation response with highest inoculation efficiency in BM-6 followed by BM-7, PL-406, DPL-62 and L-4076 and lowest in ILL-10805 followed by ILL-10951, ILL-10897 and PL-7.

In case of number of nodules/plant and dry weight of nodules all 22 germplasm showed positive inoculation efficiency. Nodules/plant was found significantly highest in BM-5 followed by BM-6, Subrata, BM-7, Hull-57 and lowest in K-75 followed by ILL-2-14, ILL-10971 and WBL-81 (Table 3).

Highest nodule weight was found in BM-5 followed by BM-7, L-4076 and ILL-10805 whereas it was lowest in ILL-237 followed by K-75, PL-7 and WBL-81. Significantly higher nodule weight due to inoculation was found in 8 of the genotypes as L-4076, BM-5, BM-6 and BM-7.

In some of the genotypes yield increased in bio inoculated condition as in ILL-2-8, Subrata, PL-4076, DPL-62, BM-5, L-4076, ILL-10971, ILL-10951, ILL-10803, ILL-237 and BM-7 whereas in others the value got reduced. Hull-57, Subrato and ILL-2-8 yielded high in both inoculated and uninoculated sets indicating their potential in the given environment. However, the increment in yield in all of these due to inoculation was not significant, another high yielder DPL-62 recorded significant increment in yield on inoculation.

Genotypes were further divided into four classes with range of inoculation efficiency and the class average was calculated for incremental magnitude of each parameter and presented in the Table 4. The result from table revealed that incremental shoot weight, nodule number and weight apart from yield was positively correlated with inoculation efficiency.

All the plant parts showed a positive correlation with inoculation efficiency of the treatment. However, when correlation was drawn between the incremental biomass in plant parts and yield irrespective of genotypes a negative correlation was found between shoot biomass, root biomass and nodule biomass and grain yield with correlation coefficient of 0.99, 0.58 and 0.55 respectively (Fig 1).

Different genotypes differed considerably with respect to their response in different locations. The number of nodules, fresh weight of nodules (mg) and dry weight of nodules (mg) for 5 lentil genotypes analyzed were presented in Table-5 and it was evident from the result that difference existed among genotypes, the genotypes performing well in one location was not performing well in other location.

From the results it was clear that, irrespective of any variety the yield was higher in Malda than Coochbehar, however, some of the contributing factors were higher in

Table 3: Effect of bio-inoculation on number of nodules, dry weight of nodules (mg), yield and inoculation efficiency of different lentil germplasm at Malda and Coochbehar carried out during 2015-2017

| Germplasms | No. of nodules | Dry weight of nodules (mg) | Yield (gm) | Inoculation efficiency% |
|------------|----------------|---------------------------|------------|-------------------------|
|            | NT  T          | NT  T                     | NT  T      | No. of nodules T dry weight of nodules Yield (gm) |
| Subrata    | 8.00 11.15 5.95 4.77 93.83 112.62 28.25 17.19 16.68  |
| ILL-10951  | 15.40 18.00 5.02 5.59 64.24 82.40 14.44 10.20 22.04  |
| L-4076     | 10.40 13.35 4.29 5.56 82.69 83.71 22.10 22.84 1.22  |
| ILL-10971  | 9.00 9.75 4.28 4.52 47.61 73.54 7.69 5.31 35.26  |
| L. HII-15  | 9.40 11.00 4.15 4.71 70.00 76.97 14.55 11.89 9.06  |
| ILL-10897  | 4.80 5.55 3.60 4.10 67.50 65.64 13.51 12.20 -2.83  |
| DPL-62     | 9.60 12.00 4.24 4.96 87.68 82.42 20.00 14.52 -6.38  |
| ILL-10805  | 5.00 6.00 3.61 4.57 74.40 72.42 16.67 21.01 -2.73  |
| LIII2-8    | 9.40 12.20 3.74 3.99 84.43 147.23 22.95 6.27 42.65  |
| LIII2-14   | 8.40 8.60 4.06 4.46 92.43 101.61 2.33 8.97 9.03  |
| PL-406     | 15.40 16.25 4.63 5.55 80.30 128.65 5.23 16.58 37.58  |
| WBL81      | 12.80 13.60 4.61 4.79 76.59 62.58 5.88 3.76 -22.39  |
| ILL-237    | 10.20 11.80 4.34 4.35 78.29 62.11 13.56 0.23 -26.05  |
| KLS-218    | 11.80 14.80 4.47 4.75 106.22 81.19 20.27 5.89 -30.83  |
| ILL-10803  | 7.20 8.25 3.92 4.82 88.41 70.78 12.73 18.67 -24.91  |
| K-75       | 11.20 11.40 4.38 4.45 70.18 74.97 1.75 1.57 6.39  |
| Hull-57    | 9.00 11.65 4.16 4.39 118.15 94.11 22.75 5.24 -25.54  |
| BM-5       | 9.20 15.35 4.29 6.16 68.85 83.06 40.07 30.36 17.11  |
| BM-7       | 6.00 8.35 3.76 5.07 108.34 80.13 28.14 25.84 -35.21  |
| BM-6       | 8.40 12.00 4.04 4.97 81.38 71.26 30.00 18.71 -14.20  |
| PL-6       | 7.45 9.00 3.95 4.27 84.91 72.96 17.22 7.49 -16.38  |
| PL-7       | 6.15 7.20 3.61 3.73 83.09 67.38 14.58 3.22 -23.32  |
| Maitry     | 6.80 8.00 3.87 4.24 83.75 72.73 15.00 8.73 -15.15  |

CD .05 1.56 0.25 3.79  SEM ± 4.56 0.74 10.58
Coochbehar like number of plants per square metre, nodule weight etc. Malda out yielded Coochbehar, probably due to higher number of branches provided by lesser number of plants per unit area contributing to higher shoot biomass.

On analysis of the data, it was found that K-75 was a stable variety at both the locations with highest yield (2.15t/ha), with comparatively higher branch number and lower shoot biomass. Irrespective of the locations, the next variety was BM-6, however, it was not a good yielder in Coochbehar, but very good yielder at Malda. BM-6 also had high number branches with high nodule weight and shoot biomass.

In Coochbehar the highest yield was recorded in K75 (1.83t/ha) with highest number of branches (9.22) and lower shoot biomass (3.61 g/plant). Rest of the varieties performed at par in Coochbehar. In Malda, the same variety yielded significantly higher than all other varieties with 2.47 t/ha and characteristically, with moderate branch number and shoot biomass. Similar to Coochbehar, other varieties performed at par with respect to yield.

Out of the selected varieties for multilocational trial, which performed better than the popular variety Maitree with a potential yield of 1.16 and 1.76 t/ha in Coochbehar and Malda tested under different projects, K-75 and BM-6 may be selected for further exploitation in the region with good adaptability and yield potential (Plate-2).

22 Lentil genotypes when tested under field condition with recommended dose of fertilizer and biofertilizers. Six genotypes ILL-2-8, PL-406, Subrata, ILL-2-14, L-4076 and ILL-10951 performed well in the field condition with higher inoculation efficiency. The data from the field trial when analyzed it showed a positive relationship between inoculation efficiency and change in harvest index due to bioinoculation and a negative relationship was found...
Plate 2: Growth response of lentil genotypes over several locations (multi location) in terai region and old alluvial zone of West Bengal.

Fig 2: Relationship between Inoculation efficiency and change in Harvest index and unit change in vegetative dry matter and change in harvest index due to bio-inoculation (Fig 2) between percent incremental dry matter accumulated in the shoot and change in harvest index due to bio-inoculation (Fig 2).

This indicated that if under a given management strategy, which may be inoculation of different microbes, if the incremental dry matter is accumulated in shoot and vegetative growth it is reflected negatively on yield with the correlation coefficient of -0.98 which was further confirmed by partitioning the incremental biomass due to bio-inoculation into shoot, root and yield. From the Fig 3 it was evident that plants with inoculation efficiency more than 20, the incremental biomass moved towards grain yield with a declining biomass for shoot or the vegetative part of the plants. With the declining inoculation efficiency the biomass accumulated more in shoot and yield gradually reduce as such in case of low inoculation efficiency due to high fertilizer dose. These results are in agreement with the findings of Erskine and Goodrich (1991), Whitehead et al. (2000) and Hanlan et al., (2006) wherein they suggested that harvest index was directly correlated with yield and greater biomass production was unlikely to improve harvest index and the Lentil genotypes that produces higher large vegetative growth bear lesser grain.

Different genotypes differed considerably with respect to their response in different location. So an experiment was conducted at two different district with 2 location each i.e. Chachal and Bijoy Nagar in Malda district and Satmile and Pundibari in Coochbehar district.
Five lentil genotypes which are responsive to bioinoculants were selected and its assessment was done in order to select the most appropriate genotypes in specific environments. From the results as mentioned above, it was evident that significant differences were found among 5 lentil genotypes for all ten characters i.e. no. of nodules, fresh weight of nodules (mg), dry weight of nodules (mg), fresh shoot biomass (g), fresh root biomass (g), dry shoot biomass (g), dry root biomass (g), no. of branches per plant, no. of plants / sq. m, yield (t/ha) in Coochbehar and Malda. The response of genotypes in different environment varied and their superiority was dependent on environment. Genotypes performing well under one location may not show equal performance in other location. Similar findings were also reported by Zilio et al., (2014); Torga et al., (2013) and Dar et al., 2009. Assessed twelve promising genotypes of common bean at three locations and observe significant differences among the genotypes. However, apart from selecting location specific varieties, a stable variety which may be adapted to different locations increases the scope of adoption of lentil as a crop in the cropping system in wider perspective. So, irrespective of locations, K-75 may be selected for wider adoption in both districts, which shows a higher yield potential than the present popular variety Maitree.

CONCLUSION

It can be concluded that irrespective of locations K-75 was a stable genotype, and the potential of the genotype may be utilized. In Malda genotype BM-6 may be utilized for higher yield potential along with K-75, but in Coochbehar no alternative other than K-75 was found suitable to replace the variety Maitree which is in vogue.

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