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# Effect of Production Components of Lentil (*Lens culinaris* Medik.) under Different Resource Constraints Practices

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## ABSTRACT

**Background:** Lentil occupy a unique place in India's nutritional food security as it's a major source of proteins for vegetarians, supply twice protein as compare to rice and wheat. India ranked second in terms of production followed by turkey producing 1.06 million tonnes (Annual Rreport DPB, 2016-17). Still lentil production far from its actual position because of farmer's negligence in terms of fertilizer, irrigation, weeding, plant protection *etc.* Based on above mention criteria experiment was conducted to find out the production components for optimization of growth and yield of lentil under resource constraints.

**Methods:** Experiment was conducted during winter season of 2016-17 and 2017-18 at the District Seed Farm, Kalyani, under Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal with a view to identify the most appropriate production components of lentil under resource constraints situation.

**Result:** Fertilizer and weeding components were more noticeable effect on plant height and escaping these two components markedly reduce the plant height in all the growth stages. Skipping of individual component like irrigation only did not vary the dry matter production significantly but when it was combined with fertilizer and weeding components the dry matter production reduced significantly. Among the individual component escaping of fertilizer component greatly reduce the number pods plant$^{-1}$ followed by weeding and irrigation components. Escaping of irrigation either as single component or in combined with weeding and plant protection did not reduce the 1000 seed weight significantly. Yield reduction was significantly noticed with escaping of production component either in single or in combination. 26-28% of yield reduction was found when component like fertilizer was escaped followed by 25-27% when weeding was escaped from full package. But no significant yield reduction was recorded under the FP-Irrigation and FP-Plant protection. The yield reduction was more pronounced (27-32%) when fertilizer along with weeding components was escaped. Weed growth and density increased with increased the crop age and number of weeds m$^{-2}$ was found maximum at 45 DAS Highest BCR was found under the treatment FP-(weeding + PP).

**Key words:** Lentil, Resource constrains, Weeding, Yield.

## INTRODUCTION

Lentil is the oldest pulse crop and most nutritious among the pulses. Lentil occupies a unique place in India's nutritional food security as it is a major source of proteins for vegetarians. Lentil contain high amount of protein (22.0-24.5%). It is supplementing the staple cereals in the diets with health-sustaining ingredients *viz.*, proteins, essential amino acids, vitamins and minerals. Among the *rabi* pulses, Lentil is second most of the important next to chickpea in India. However, the production of pulses is not keeping pace with growing population in the country. India ranks first in area as well as production in lentil followed by Turkey but the productivity remains low. As it is mostly cultivated on marginal and sub marginal lands in rainfed areas where it is estimated that drought and heat stress influence 50% reduction in seed yields particularly in arid and semi-arid regions of the country. Cultivation is mostly confined in marginal and sub marginal land with less care under energy starved condition. Still, it is a neglected crop due to a part to follow poor management practices starting from land preparation, sowing technique, weeding *etc.* to post harvest operation. The experiment was undertaken with a view to find out the production components for optimization of growth and yield of lentil under resource constraints and finally its validation through economic analysis.

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## MATERIALS AND METHODS

The experiment was carried out during winter seasons of 2016-17 and 2017-18 at the District Seed Farm, Kalyani, under Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal. The experimental field was alluvium and sandy loam in texture with moderate organic matter content and soil pH was 7.1. The four major production components *viz.*, fertilizer, weeding, irrigation and plant protection were considered. The experiment was laid out in a randomized block design with three replications keeping the plot size

4 m × 3 m using 12 (twelve) treatment combinations *viz.*, $T_1$: Full package (FP); $T_2$: FP-Fertilizer; $T_3$: FP- irrigation; $T_4$: FP- weeding; $T_5$: FP-plant protection; $T_6$: FP-(Fertilizer + irrigation); $T_7$: FP-(Fertilizer + weeding); $T_8$: FP- (Fertilizer + PP); $T_9$: FP-(weeding +irrigation); $T_{10}$: FP-(PP+ irrigation); $T_{11}$: FP-(weeding + PP) and $T_{12}$: FP- (Fertilizer + irrigation + weeding + PP). The variety Moitree (WBL 77) is a long duration (110-120 days) variety recommended for north eastern plain zone developed from Pulse and oilseed Research Station, Berhampore, Government of West Bengal was sown in 8$^{th}$ and 13$^{th}$ November during both the years, respectively. Seeds are treated with proper rhizobium culture one day before sowing and before sowing seeds were treated with mixture of Mancozeb and Carbendazim (SAAF) at the rate of 3 g $kg^{-1}$. Line sowing method was followed with maintaining 30 cm × 5 cm spacing. Full package (FP) means application of recommended dose of fertilizer (20:40:40 kg $ha^{-1}$ N:P:K), Irrigation at 45 days after sowing and at pod filling stage, weeding done at 15 DAS and 40 DAS and spraying of plant protection chemical was sprayed at 20 DAS and 60 DAS. Minus (-) sign denoted as avoidance of those particular component and plus (+) sign as combination of components.

Growth and yield parameters like plant height at 60 DAS and at harvest, total dry matter accumulation at 45, 60, 75 days after sowing and at harvest, no. of nodule per plant, nodule dry weight, number of pods, no. of seed per pod, 1000 seed weight, seed yield, Stover yield, harvest index and soil available NPK at harvest was recorded. An evaluation of the statistical significance of the data collected during the investigation was conducted by the application of Cochran and Cox (1967), using the F-test and comparing the results using Table F at 5%. Likewise, S.Em. and C.V.% was calculated. Correlation analysis was done using IBM SPSS Statistics software (Field, 2013), by considering lentil characteristics and growth promoting components.

## RESULTS AND DISCUSSION

### Growth attributes

Plant height towards maturity increased significantly and from the Table 1 it was observed that significantly higher plant height was recorded under full package of practices under the treatment $T_1$ (36.6 cm) at 60 DAS. Plant height decreased gradually with escaping of production components either single or in combinations and was significantly decreased when all the components were escaped under the treatment $T_{12}$ (30.9cm) but all other treatments ($T_2$ - $T_{11}$) were statistically at par with $T_1$. Among the production components only sacrificing of fertilizer showed the significant effect on lowering the plant height at all the growth stages. At early stage sacrificing of weeding did not hampered the plant height significantly because of slower growth of weed including crop but after 60 DAS onwards weeding has significant role to increase the plant height. Fertilizer and weeding components were more noticeable effect on plant height and escaping these two components markedly reduce the plant height in all the growth stages. Similar observation was also reported by Vimala and Natarajan (2000).

Dry matter accumulation was very much related with the production components and dry matter production decreased if the production components are escaped either single component or in combinations. Dry matter production decreased with escaping the single component like fertilizer and weeding ($T_2$ and $T_4$, respectively) and dry matter production was further reduced when the components were escaped in combinations and significantly lower dry matter production was obtained with $T_{12}$ where all the production components were escaped. From the Table 1 it was also revealed that skipping of individual component like irrigation only did not vary the dry matter production significantly but when it was combined with fertilizer and weeding components the dry matter production reduced significantly. This might be due to the lower evapo-transpiration loss leads to demand of less moisture *vis-a-vis* when it was combined with fertilizer the growth was reduced further due to plants did not uptake the nutrients properly, only to meet up from leaf tissues. Weed by nature itself has the capacity to draw the moisture from the deeper layer of the soil under sufficiency or deficiency range. In addition, lentil roots are relatively shallow which allow moderate drought resistance; however, this limits the uptake of water and nutrients when in competition with weeds. Dry matter production increased with increasing the age of the crop and was found maximum at harvest. This might be due to that lentil accumulated more dry matter and nitrogen content during the latter part of the growing season because the reproductive plant parts had higher values for% Ndfa (percentage of N derived from the atmosphere) than the vegetative components. Similar observation was also stated by Van Kessel (1994); Tomar *et al.* (2000); Yamane and Dastane (2003).

Number of nodules $plant^{-1}$ increased with increasing the age of the crop and was found maximum at 60 DAS. From the Table 1 it was found that number of nodules decreased with skipping of production components and it was more profound in escaping of fertilizer followed by weeding. Watt and Singh (1992) also reported the similar finding. But irrigation had no significant influence to increase the nodule number but when it was escaped along with fertilizer and weeding components, nodule number decreased significantly. Nodule number further decreased when production components were escaped in combination in all the growth stages. Nodule dry weight of lentil increased with full package of practices. But dry weight of nodule $plant^{-1}$ further decreased with escaping of production components. Nodule dry weight was significantly reduced with escaping of components like fertilizer and weeding but as individual component irrigation and plant protection had no significant influence to increase the nodule dry weight. But when all components were escaped from full package ($T_{12}$) the nodule dry weight was decreased significantly.

**Table 1:** Effect of production components on growth attributes of lentil (pooled over two years).

| Treatment | Crop growth attributes | | | | | | |
|---|---|---|---|---|---|---|---|
| | Plant height (cm) | | Dry matter accumulation (g $m^{-2}$) | | | No of nodule $plant^{-1}$ | Nodule dry weight (mg $plant^{-1}$) |
| | 60 DAS | At harvest | 45 DAS | 60 DAS | 75 DAS | 60 DAS | 60 DAS |
| $T_1$: Full package (FP) | 36.6 | 53.7 | 26.8 | 99.4 | 225.0 | 29.7 | 4.9 |
| $T_2$: FP- Fertilizer | 34.2 | 51.9 | 17.3 | 66.1 | 182.0 | 22.5 | 3.8 |
| $T_3$: FP- irrigation | 34.9 | 48.9 | 22.4 | 77.9 | 202.3 | 24.9 | 4.3 |
| $T_4$: FP- weeding | 33.6 | 49.5 | 18.8 | 72.7 | 178.6 | 23.7 | 4.5 |
| $T_5$: FP- plant protection | 35.0 | 53.0 | 23.3 | 82.9 | 200.5 | 29.7 | 4.4 |
| $T_6$: FP- (Fertilizer + irrigation) | 33.4 | 48.4 | 15.9 | 71.9 | 172.2 | 20.5 | 2.9 |
| $T_7$: FP- (Fertilizer + weeding) | 33.1 | 49.7 | 14.9 | 61.5 | 159.7 | 19.0 | 3.9 |
| $T_8$: FP- (Fertilizer + PP) | 33.2 | 51.3 | 17.0 | 68.4 | 182.3 | 22.0 | 4.2 |
| $T_9$: FP- (weeding + irrigation) | 33.7 | 49.6 | 17.2 | 66.4 | 172.6 | 19.7 | 3.7 |
| $T_{10}$: FP- (PP+ irrigation) | 34.7 | 51.1 | 22.4 | 94.5 | 192.7 | 25.4 | 2.9 |
| $T_{11}$: FP- (weeding + PP) | 35.1 | 51.9 | 18.0 | 74.8 | 196.2 | 22.5 | 3.2 |
| $T_{12}$: FP- (Fertilizer + irrigation + weeding + PP) | 30.9 | 46.9 | 12.6 | 51.8 | 147.5 | 16.1 | 2.0 |
| SEm (±) | 1.20 | 1.72 | 1.52 | 4.30 | 18.10 | 1.27 | 0.18 |
| CD (P = 0.05) | 3.44 | NS | 4.33 | 17.35 | 29.35 | 3.74 | 0.53 |

FP: Full package; PP: Plant protection; NS: Non significant.

### Yield attributes and yield

All the production components had the significant influence to increase the number of pods plant $^{-1}$ except escaping of plant protection as a single component had no significant influence to reduce the number of pods plant$^{-1}$. Among the individual component escaping of fertilizer component greatly reduce the number pods plant$^{-1}$ followed by weeding and irrigation components. This might be due to the escaping the fertilizer application produce weak plants as the growth and development hamper the effect was also in reproduction components. Similar finding was also reported by Singh and Singh (1991); Anaam *et al.*, (2003) and Zafar *et al.*, (2003). Number of seed pod$^{-1}$ was significantly affected by sacrificing of production components either in single or in combinations. From the table 02 it was observed that number of seeds pod$^{-1}$ was found maximum under the treatment $T_1$ (Full package) and was reduced significantly when the production components were escaped and also it was more pronounced in treatment $T_2$ (FP- Fertilizer) and $T_4$ (FP- Weeding) during individual year as well as pooled analysis. Escaping of irrigation components as a single component had no significant influence to decrease the number of seeds pod$^{-1}$ but when it was escaped along with fertilizer, number of seeds pod$^{-1}$ reduced significantly. So the production component of fertilizer was most imperative which had the considerable influence on yield attributes of lentil. This finding is an agreement with Zafar *et al.* (2003). Test weight (1000 seed weight) was significantly reduced with escaping of fertilizer component as compared to other components like Weeding, Irrigation and plant protection. From the Table 2 it was revealed that irrigation and weeding had significantly reduced the 1000 seed weight when it was collectively escaped with fertilizer. Escaping of irrigation either as single component or in combined with weeding and plant protection did not reduce the 1000 seed weight significantly. This might be due to escaping of irrigation particularly later stage helps to inhibit the further continuing of lateral branches including flowers and ineffective pods and prevailing of drought by escaping irrigation enhanced partitioning of assimilates to seeds by reducing sink-source competition.

Seed yield of lentil was increased when all production components were considered *i.e.* Full package. Each and every component had the significant influence to increase the seed yield. But yield reduction was significantly noticed with escaping of production component either in single or in combination. From the Table 3 it was revealed that among the production components yield reduced significantly under $T_2$ (FP-Fertilizer) followed by $T_4$ (FP-Weeding) but under the treatment $T_3$ (FP-irrigation) and $T_5$ (FP-Plant protection) yield was reduced but they were statistically at par with T1 (FP) during individual year as well as pooled analysis. Singh and Singh (1994); Saha *et al.* (2004) reported the similar observation.

Like seed yield, stover yield was also greatly affected by escaping of fertilizer component followed by weeding rather than escaping of irrigation and plant protection component during individual year as well as pooled analysis. Stover yield was further reduced when components were escaped in combined way and significantly lower stover yield was obtained with the treatment $T_{12}$ where all the production components were escaped from full package ($T_1$). Escaping of irrigation component alone did not reduce the stover yield significantly but when it was combined with fertilizer and weeding the stover yield reduced significantly.

Each and every component had the significant influence to increase the seed yield. But yield reduction was significantly noticed with escaping of production component either in single or in combination. 26-28% of yield reduction was found when fertilizer was escaped ($T_2$) followed by 25-27% when weeding was escaped ($T_4$) from full package ($T_1$). But no significant yield reduction was recorded under the treatment $T_3$ (FP-Irrigation) and $T_5$ (FP-Plant protection). The yield reduction was more pronounced (27-32%) when fertilizers along with weeding components together were escaped. This might be due to lentil being a protein rich high energy crop deficiency of nutrients in any stage greatly hampered the growth and yield. Under this situation when both soil and atmospheric N sources are limited, only translocation of N from the pre-existing N pool in vegetative tissues became the major source of N for pod filling. $N_2$ fixation in legumes is highest between flowering and early pod fill and all legumes derived about 90% of their N from the atmosphere by 80 days after emergence and it continued to fix N until the end of the pod fill stage. Again, phosphorus (P) and nitrogen (N) play specific roles in symbiotic $N_2$-fixation through their effects on nodulation and $N_2$-fixation process and symbiotic nitrogen fixation has a high P demand indirectly because the process consumes large amounts of energy and energy generating metabolism strongly depends upon the availability of P. In addition, control of weeds during the emergence and vegetative stages were more important to prevent competition for nutrients, water and photo-synthetically active radiation (PAR). Harvest index did not influence by escaping any production component either in single or in combinations.

**Weed density and weed dry matter**

Weed intensity is governed by the nature of treatment applied and the interval maintained. Weed growth and density increased with increased the crop age and number of weeds $m^{-2}$ was found maximum at 45 DAS. Broad leaf weeds found maximum followed by sedges and grasses during all the growth stages. Lentil being a slow growing crop weed infestation was more pronounced at early stages of the crop growth but at later stages towards maturity weed was less competitive to crop because of high as well as tall branching and canopy including interception of lower sunlight discouraged the weed growth. As number of weeds increased, the dry matter of weed also increased. From the Table 3 it was found that weed dry matter was found maximum under the treatment where fertilizer was used with or without weeding operation.

**Soil available nutrient**

Available NPK was found maximum under the treatment $T_1$ where all the production components were considered. Lower available NPK was obtained with the treatment $T_{12}$ where all the production components were escaped. Among the individual component escaping of fertilizer showed the lower available NPK followed by Weeding, irrigation and plant protection. Available NPK was further reduced when fertilizer component was escaped with weeding and irrigation. This was due to occurrence of weed along with non-application of fertilizer. Nutrient uptake was more competitive with plant and weed as result of less availability of NPK.

**Economics**

From Table 3, highest gross return (Rs. 77760, Rs. 74240 and Rs. 76000 during 2016-17, 2017-18 and mean over two years, respectively) was recorded under the treatment $T_1$ (Full package), Net return was found maximum under the treatment $T_5$ (Rs. 43449 during 2016-17), $T_1$ (Rs. 34427 during 2016-17) and under the treatment $T_5$ (Rs.38811 mean

**Table 2:** Effect of production components on yield attributes and yield of lentil (pooled over two years).

| Treatment | Yield attributes and yield | | | | | | |
|---|---|---|---|---|---|---|---|
| | No. of pod plant$^{-1}$ | No. of seed pod$^{-1}$ | Test weight (g) | Seed yield | Stover yield | Yield reduction (%) | Harvest index (%) |
| $T_1$: Full package (FP) | 61.3 | 1.6 | 19.3 | 1900 | 3164 | 0 | 37.6 |
| $T_2$: FP- Fertilizer | 38.5 | 1.5 | 17.9 | 1391 | 2818 | 26.8 | 33.1 |
| $T_3$: FP- Irrigation | 49.4 | 1.6 | 19.1 | 1773 | 3074 | 6.7 | 36.7 |
| $T_4$: FP- Weeding | 41.6 | 1.5 | 18.6 | 1410 | 2740 | 25.8 | 34.1 |
| $T_5$: FP- Plant protection | 57.2 | 1.6 | 19.0 | 1831 | 3079 | 3.7 | 37.3 |
| $T_6$: FP- (Fertilizer + irrigation) | 39.8 | 1.4 | 18.0 | 1439 | 2693 | 24.3 | 34.9 |
| $T_7$: FP- (Fertilizer + weeding) | 33.7 | 1.5 | 18.3 | 1337 | 2613 | 29.6 | 34.1 |
| $T_8$: FP- (Fertilizer + PP) | 42.7 | 1.6 | 18.1 | 1469 | 2858 | 22.7 | 34.2 |
| $T_9$: FP- (Weeding + irrigation) | 38.5 | 1.6 | 18.0 | 1410 | 2759 | 25.8 | 35.3 |
| $T_{10}$: FP- (PP+ irrigation) | 51.3 | 1.6 | 18.6 | 1699 | 2991 | 10.6 | 36.3 |
| $T_{11}$: FP- (Weeding + PP) | 36.4 | 1.5 | 18.6 | 1445 | 2943 | 24.0 | 33.2 |
| $T_{12}$: FP- (Fertilizer + irrigation + weeding + PP) | 30.0 | 1.4 | 17.6 | 823 | 2403 | 56.7 | 25.9 |
| SEm (±) | 1.07 | 0.01 | 0.21 | 55.01 | 99.21 | - | - |
| CD (P = 0.05) | 3.05 | 0.04 | 0.59 | 156.7 | 282.7 | - | - |

FP: Full package; PP: Plant protection; NS: Non significant.

**Table 3:** Effect of production components on Economics, Weed and Soil available nutrients (pooled over two years).

| Treatment | Economics, weed and soil available nutrient | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gross return (Rs $ha^{-1}$) | Total cost (Rs $ha^{-1}$) | Net return (Rs $ha^{-1}$) | BCR | Weed density ($m^{-2}$) | | Weed dry matter (g $m^{-2}$) | | Nitrogen (kg $ha^{-1}$) | Phosphorus (kg $ha^{-1}$) | Potassium (kg $ha^{-1}$) |
| | | | | | 20 DAS | 45 DAS | 20 DAS | 45 DAS | | | |
| $T_1$: Full package (FP) | 76000 | 37359 | 22200 | 2.05 | 12 | 16 | 7.62 | 10.77 | 250.25 | 24.9 | 213.7 |
| $T_2$: FP- Fertilizer | 55620 | 33420 | 36396 | 1.68 | 19 | 13.5 | 10.84 | 8.18 | 200.05 | 21.25 | 208.8 |
| $T_3$: FP- Irrigation | 70900 | 34504 | 27656 | 2.08 | 12.5 | 13 | 8.13 | 9.11 | 234.4 | 22.6 | 212.6 |
| $T_4$: FP- Weeding | 56400 | 28744 | 38811 | 1.97 | 35.5 | 81.5 | 33.61 | 78.28 | 230.25 | 22.3 | 211.55 |
| $T_5$: FP- Plant protection | 73220 | 34409 | 26570 | 2.15 | 9.5 | 12 | 6.02 | 7.94 | 239.9 | 23.1 | 212.9 |
| $T_6$: FP- (Fertilizer + irrigation) | 57560 | 30990 | 28230 | 1.88 | 9 | 11 | 6.42 | 8.3 | 195.55 | 19.7 | 208 |
| $T_7$: FP- (Fertilizer + weeding) | 53460 | 25230 | 27865 | 2.13 | 36 | 79 | 26.48 | 61.03 | 195.05 | 18.75 | 206.3 |
| $T_8$: FP- (Fertilizer +PP) | 58760 | 30895 | 30066 | 1.93 | 11 | 10.5 | 7.06 | 7.56 | 210.3 | 20.65 | 207.2 |
| $T_9$: FP- (Weeding + irrigation) | 56380 | 26314 | 35961 | 2.16 | 36 | 70 | 30.05 | 61.13 | 224.15 | 22.2 | 212.15 |
| $T_{10}$: FP- (PP+ irrigation) | 67940 | 31979 | 31581 | 2.15 | 8 | 16 | 5.48 | 12.17 | 234.25 | 22.95 | 213 |
| $T_{11}$: FP- (Weeding + PP) | 57800 | 26219 | 12625 | 2.22 | 36.5 | 83.5 | 28.67 | 69.06 | 223.5 | 22.55 | 212.65 |
| $T_{12}$: FP- (Fertilizer + irrigation + weeding + PP) | 32900 | 20275 | 22200 | 1.64 | 40 | 92.5 | 30.61 | 72.10 | 184.1 | 18.4 | 189.15 |
| SEm (±) | - | - | - | - | 1.63 | 0.32 | 0.86 | 1.11 | 1.89 | 0.51 | 0.42 |
| CD (P = 0.05) | - | - | - | - | 4.04 | NS | 2.13 | 2.76 | 5.39 | 1.45 | 1.22 |

FP: Full package; PP: Plant protection; NS: Non significant.

**Table 4:** Correlation analysis among the lentil characteristics, weed and soil available nutrients.

| | Correlations | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Plant height at 60 DAS | Plant height at harvest | Dry matter accu-mulation at 45 DAS | Dry matter accu-mulation at 60 DAS | Dry matter accu-mulation at 75 DAS | No. of nodule at 60 DAS | Nodule dry wt. at 60 DAS | No. of pod per plant | No. of seed per pod | 1000 seed weight | Weed density at 20 DAS | Weed density at 45 DAS | Weed dry matter at 20 DAS | Weed dry matter at 45 DAS | Soil available nitrogen | Soil available phosphorus | Soil available potassium | Seed yield |
| Plant height at 60 DAS | 1 | .799** | .892** | .869** | .953** | .868** | .626* | .796** | .634* | .840** | -.497 | -.493 | -.474 | -.464 | .838** | .897** | .859** | .908** |
| Plant height at harvest | .799** | 1 | .692* | .673* | .774** | .784** | .592* | .668* | .605* | .575 | -.424 | -.444 | -.438 | -.435 | .626* | .714** | .642* | .700* |
| Dry matter accumulation at 45 DAS | .892** | .692* | 1 | .934** | .939** | .955** | .630* | .963** | .722** | .906** | -.605* | -.560 | -.555 | -.526 | .926** | .916** | .713** | .924** |
| Dry matter accumulation at 60DAS | .869** | .673* | .934** | 1 | .886** | .883** | .445 | .904** | .609* | .815** | -.645* | -.560 | -.584* | -.525 | .851** | .858** | .719** | .883** |
| Dry matter accumulation at 75 DAS | .953** | .774** | .939** | .886** | 1 | .915** | .630* | .874** | .667* | .869** | -.588* | -.569 | -.557 | -.539 | .870** | .915** | .751** | .903** |
| No of nodule at 60 DAS | .868** | .784** | .955** | .883** | .915** | 1 | .674* | .950** | .658* | .874** | -.641* | -.600* | -.590* | -.561 | .872** | .868** | .714** | .914** |
| Nodule dry wt. at 60 DAS | .626* | .592* | .630* | .445 | .630* | .674* | 1 | .612* | .644* | .674* | -.286 | -.338 | -.240 | -.284 | .641* | .595* | .656* | .690* |
| No. of pod per plant | .796** | .668* | .963** | .904** | .874** | .950** | .612* | 1 | .701* | .833** | -.733** | -.679* | -.680* | -.648* | .851** | .821** | .627* | .911** |
| No. of seed per pod | .634* | .605* | .722** | .609* | .667* | .658* | .644* | .701* | 1 | .618* | -.424 | -.435 | -.393 | -.405 | .778** | .719** | .664* | .751** |
| 1000 seed weight | .840** | .575 | .906** | .815** | .869** | .874** | .674* | .833** | .618* | 1 | -.410 | -.338 | -.358 | -.308 | .881** | .803** | .688* | .865** |
| Weed density at 20 DAS | -.497 | -.424 | -.605* | -.645* | -.588* | -.641* | -.286 | -.733** | -.424 | -.410 | 1 | .975** | .983** | .964** | -.375 | -.390 | -.421 | -.710** |
| Weed density at 45 DAS | -.493 | -.444 | -.560 | -.560 | -.569 | -.600* | -.338 | -.679* | -.435 | -.338 | .975** | 1 | .977** | .992** | -.320 | -.372 | -.424 | -.680* |
| Weed dry matter at 20 DAS | -.474 | -.438 | -.555 | -.584* | -.557 | -.590* | -.240 | -.680* | -.393 | -.358 | .983** | .977** | 1 | .988** | -.288 | -.322 | -.349 | -.662* |
| Weed dry matter at 45 DAS | -.464 | -.435 | -.526 | -.525 | -.539 | -.561 | -.284 | -.648* | -.405 | -.308 | .964** | .992** | .988** | 1 | -.260 | -.315 | -.355 | -.642* |
| Soil available nitrogen | .838** | .626* | .926** | .851** | .870** | .872** | .641* | .851** | .778** | .881** | -.375 | -.320 | -.288 | -.260 | 1 | .959** | .775** | .850** |

**Table 4: Continue...**

**Table 4: Continue...**

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Soil available phosphorus | .897** | .714** | .916** | .858** | .915** | .868** | .595* | .821** | .719** | .803** | -.390 | -.372 | -.322 | -.315 | .959** | 1 | .787** | .825** |
| Soil available potassium | .859** | .642* | .713** | .719** | .751** | .714** | .656* | .627* | .664* | .688* | -.421 | -.424 | -.349 | -.355 | .775** | .787** | 1 | .857** |
| Seed yield | .908** | .700* | .924** | .883** | .903** | .914** | .690* | .911** | .751** | .865** | -.710** | -.680* | -.662* | -.642* | .850** | .825** | .857** | 1 |

**. Correlation is significant at the 0.01 level; *. Correlation is significant at the 0.05 level.

of two years). Highest BCR was found under the treatment $T_{11}$ FP- (Weeding + PP). Escaping of more than one identifying components were beneficial than escaping of single component as the higher production cost was involved.

**Correlation**

A significant positive correlation has been found in seed yield with plant height at 60 DAS and at harvest, drymatter accumulation at 45, 60 and 70 DAS, no. of nodule at 60 DAS, no of pod per plant, no of seed per pod, 1000 seed weight, soil available nitrogen, phosphorus and potassium after harvest at 0.01 level and significant positive correlation with nodule dry weight at 60 DAS at 0.05 level. Weed density and weed dry matter at both 20 and 45 DAS are negatively correlated with yield at 0.01 levels (Table 4).

## CONCLUSION

Lentil production will be more remunerative and sustainable when all the major production components will be considered followed by the appropriate sowing time. Under resource constraints situation plant protection measures and irrigation may be escaped but fertilizer application and weeding operation at early growth stage could not be sacrificed to get the optimum yield.

**Conflict of interest:** None.

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