Effect of different levels of inorganic fertilizers on the growth and yield of Barley (*Hordeum vulgare)* under teak (*Tectona grandis*) based Agrisilviculture system

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Abstract: In order to investigate the effect of nitrogen, phosphorus, potassium, application on Barley (*Hordeum vulgare*) a field experiment was conducted at School of Forestry and Environment, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad (U.P) India, to evaluate the Effect of different levels of inorganic fertilizers on the growth and yield of barley (*Hordeum vulgare)* under teak (*Tectona grandis*) based Agrisilviculture system. A total of nine treatments including control were replicated three times in RBD experimental design. The effect of NPK fertilsers reveled that treatment T_4 (N.P.K level 65:50:50 kg/ha) favored maximum all the growth and yield parameters of barley (*Hordeum vulgare)* like the maximum plant height 92.20cm, No. of leaves per plant (8.53), No. of tillers per hill 10.93, number of spike per hill (6.87), 1000 seed weight 47.73 gm, Length of spike 15.67cm, No. of grain per spike 55.10, grain yield per plant 33.13 gm & straw yield 45.27gm/plant and harvest index 43.82. Contrary all these parameters were found minimum under control condition (without fertilizer). 71.87 cm, 5.33, 5.53, 2.47, 30.37, 9.13, 43.33, 30.33, 38.50, and 42.26 respectively for same parameters. The intercropping of Barley with Teak also showed the net increase in economic yield compare to sole cropping.
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1. Introduction

Barley is one of the most important cereals of the world. It is cultivated in almost all parts of the world except the tropical regions. Barley is a major source of food for large number of people living in the cooler semi-arid areas of the world, where wheat and other cereals are less well adapted. It is a stable food of the people in the Tibet, Nepal and Bhutan. In European countries it is used only as breakfast food. The leading countries of its production are USSR, China, France, Canada, USA and Spain. Barley is an important cereal in India. Total area under barley in the country is about 0.7 million hectares. The chief barley growing regions in the country are higher Himalayas, central parts of eastern Uttar Pradesh, eastern parts of Rajasthan and north western parts of north Bihar. The most important uses of barley in India are as grain feed to livestock and poultry, as malt for manufacture of beer and other liquors like whisky, brandy etc. As food barley flour is used in preparing 'chapatis'. Sometimes barley is mixed with gram or wheat and then ground to flour for preparing better quantity 'chapatis'. Grain is roasted and ground and used as 'sattu' (barley flour mixed in sugar and water). Grain is also broken and roughly ground into 'barley' to be used in soup. Barley grain contains, 11.5 percent albuminoids, 74 percent carbohydrates, 1.3 percent fat, 3.9 percent crude fibre and 1.5 percent ash (Singh *et. al*.).

Teak (*Tectona grandis*) is a very valuable timber species of Central India. Due to its high demand in world trade and lack of unsustainable supply from forests, large scale teak plantations have been taken up outside the forests. To encourage plantation's their scientific management and marketing unique schemes of *Lok Vaniki* was adopted in Madhya Pradesh farmers and owners of trees. Teak has so far been the monopoly of large landholders and Its potential for poor small landholders as a tree based livelihood option has received less attention. The analysis of Teak plantations in state advocates that it can also contribute to poverty reduction and enhance livelihood in rural areas. The issues relating to adoption of Teak under agroforestry by different landholders, technology packages suitable for small farmers, market access, information and viability need to be answered. The current policies, legal and regulatory framework, innovations and suitable technology are to be outlined (Pramod Shukla, 2014).

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2. Materials and Methods

The present research work was carried out at the experimental field of Forest Nursery and Research Centre, School of Forestry and Environment SHIATS

Allahabad, (Deemed to-be University), during the period from November, 2015 to March, 2016 with Ratana variety of barley in a fourteen year old teak plantation with row to row spacing 10 x10 meter and tree to tree spacing 4 x4 meter. The treats were T0 control (without fertilizer), T1- N:P:K@20:50:50, T2- N:P:K@35:50:50, T3- N:P:K@50:50:50, T4- N:P:K@ 65:50:50, T5- N:P:K@80:50:50, T6- N:P:K@95:50:50, T7- N:P:K@110:50:50, and T8- N:P:K@125:50:50. The experimental research site is situated at an altitude of 98 meters above the sea level at 28.52^0 N latitude and 81.50^0 E longitudes. The soil of the field was sandy loam, having pH 7.5. The experiment was arranged in Randomized Block Design with three replications, each replicated field was divided into nine treatments with each plot size is $4m^2$. Pre sowing soil samples up to 30 cm depth were collected and analyzed for their physico-chemical properties such as Organic carbon (%) **(**Walkey and Black's (1947), total nitrogen (kg/ha.) by Alkaline permanganate method—(Subhaiah Asija, 1956), phosphorus (kg/ha.) by Olsen's Calorimetric Method (Olsen *et al.*1954), and potassium (kg/ha.) by Flame Photometric Method (Toth and Prince, 1949). Soil p^H and EC measured by Digital p^H meter and conductivity meter respectively. The requisite agronomic and plant protection measures were adopted uniformly for all the treatments during the entire growing period. At maturity, data on plant characters and yield components were recorded from five randomly selected plants in each plot. The growth and yield characters were recorded such as plant height at harvest (cm), number of total tillers $plant^{-1}$, spike length (cm), number of spike lets $spike^{-1}$, number of grains $spike^{-1}$, 1000-seed weight (g), grain yield (t ha^{-1}), straw yield (t ha^{-1}), and harvest index (%). The crop from each unit plot was harvested at full maturity to record the data on grain and straw yields. The data was analyzed statistically.

3. Results and Discussion

Result showed that plant height increased progressively in line sowing. The maximum plant height (92.20 cm), Number of leaves (8.53), total tillers $plant^{-1}$ (10.93), Number of spike $hill^{-1}$, spike length (15.67 cm), grains $spike^{-1}$ (55.10), 1000-grain weight (42.73), grain yield (33.13 q ha^{-1}), straw yield (45.27q ha^{-1}), and harvest index (43.82 %) were obtained**.**

Plant height (cm)

From the table 1 and Fig. 1, at 90 DAS, it was observed that different treatment combination of plant height was affect significantly. The maximum plant height (cm) was found in treatment T_4- 65: 50: 50 i.e. (92.20 cm) followed by treatment $T_3$50: 50: 50 i.e. (88.30 cm) and minimum plant height was observed in T_0 control i.e. (71.87 cm).

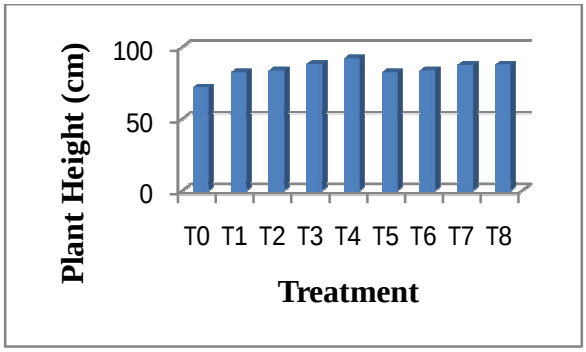

Fig.1. Plant height (cm) of Barley (*Hordeum vulgare* L.) as influenced by different levels of inorganic fertilizers under Teak (*Tectona grandis*) at different intervals after sowing

Number of leaves per plant

From the table 1 and Fig. 2, at 90 DAS, the maximum number of leaves per plant was found in treatment $T_4$65: 50: 50 i.e. (8.53) followed by treatment $T_3$50: 50: 50 i.e. (7.87) and minimum number of leaves per plant was observed in T_0 control i.e. (5.33).

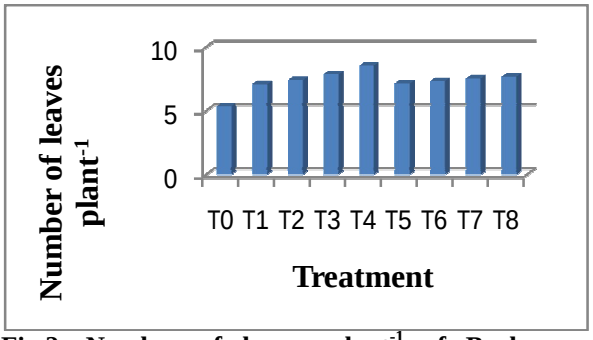

Fig.2. Number of leaves $plant^{-1}$ of Barley as influenced by different levels of inorganic fertilizers under Teak based agrisilviculture system

Numbers of tillers per hill

From the table 1 and Fig. 3, it was observed that the numbers of tillers per hill was significantly influenced by different treatment combinations at different fertilizers levels. At 90 DAS, it was observed that different treatment combination of numbers of tillers per hill was affect significantly. The maximum numbers of tillers per hill was found in treatment $T_4$65: 50: 50 i.e. (10.93) followed by treatment $T_3$50: 50: 50 i.e. (9.53) and minimum numbers of tillers per hill was observed in T_0 control i.e. (5.53).

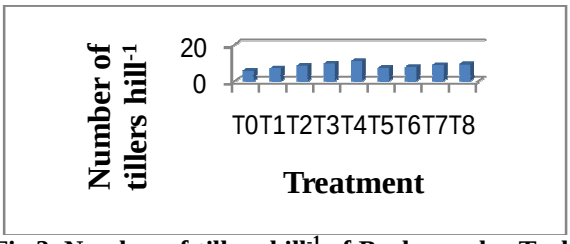

Fig.3. Number of tillers hill^{-1} of Barley under Teak based agrisilviculture system

Number of spike per hill

From the table 1 and Fig. 4, it was observed that the number of spike per hill was significantly influenced by different treatment combinations at different fertilizers levels. The maximum number of spike per hill was found in treatment $T_4$65: 50: 50 i.e. (6.87) followed by treatment $T_3$50: 50: 50 i.e. (5.93) and minimum number of spike per hill was observed in T_0 control i.e. (2.47).

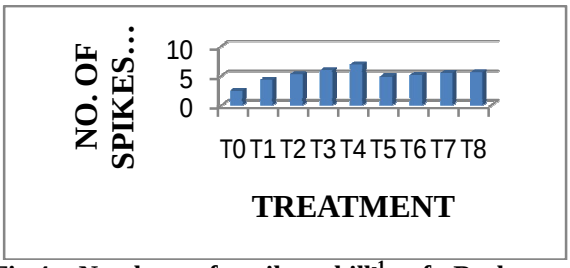

Fig.4. Number of spikes hill^{-1} of Barley as influenced by different levels of inorganic fertilizers under Teak based agrisilviculture system

Grain Number Spike^{-1}

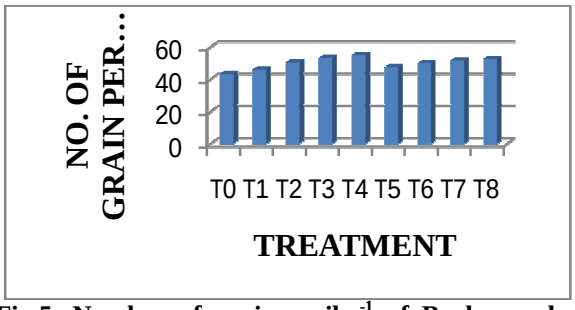

Fig.5. Number of grains spike^{-1} of Barley under Teak based agrisilviculture system

From the table 1 and Fig. 5, it was observed that the grain number spike^{-1}was significantly influenced by different treatment combinations at different fertilizers levels. At 90 DAS, it was observed that different treatment combination of grain number spike^{-1} was affect significantly. The maximum grain number spike^{-1} was found in treatment $T_4$65: 50: 50 i.e. (55.10) followed by treatment $T_3$50: 50: 50 i.e. (53.37) and grain number spike^{-1} was observed in T_0 control i.e. (43.33).

Length of spike (cm)

From the table 1 and Fig. 6, it was observed that the length of spike was significantly influenced by different treatment combinations at different fertilizers levels. At 90 DAS, it was observed that different treatment combination of length of spike was affect significantly. The maximum length of spike was found in treatment $T_4$65: 50: 50 i.e. (15.67) followed by treatment $T_3$50: 50: 50 i.e. (14.73) and length of spike was observed in T_0 control i.e. (9.13).

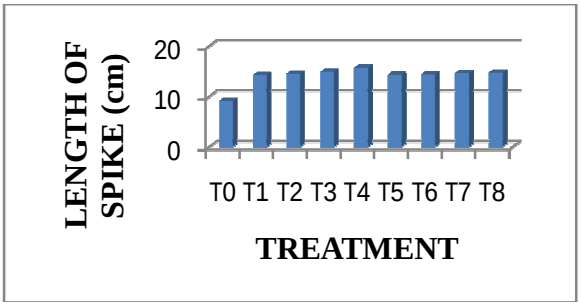

Fig. 6. Length of spike (cm) of Barley as influenced by different levels of inorganic fertilizers under Teak based agrisilviculture system

Test weight (1000-grain Weight (g))

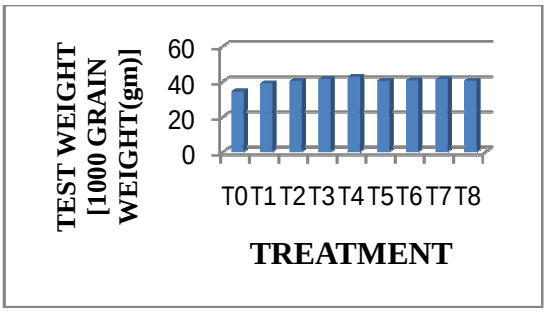

Fig. 7. Test weight (1000-grain weight) (g) of Barley (*Hordeum vulgare* L.) as influenced by different levels of inorganic fertilizers under Teak (*Tectona grandis*) based agrisilviculture system

From the table 1 and Fig. 7, it was observed that the 1000-Grain Weight was significantly influenced by different treatment combinations at different fertilizers levels. At 90 DAS, it was observed that different treatment combination of 1000-Grain Weight was affect significantly. The maximum 1000-Grain Weight was found in treatment $T_4$65: 50: 50 i.e. (42.73) followed by treatment $T_3$50: 50: 50 i.e. (41.47) and 1000-Grain Weight was observed in T_0 control i.e. (34.32).

Grain yield (q/h)

From the table 1 and Fig. 8, it was observed that the Grain yield was significantly influenced by different treatment combinations at different fertilizers levels. At 90 DAS, it was observed that different treatment combination of Grain yield was affect significantly. The maximum Grain yield was found in treatment $T_4$65: 50: 50 i.e. (33.13) followed by treatment $T_3$50: 50: 50 i.e. (32.44) and Grain yield was observed in T_0 control i.e. (30.03).

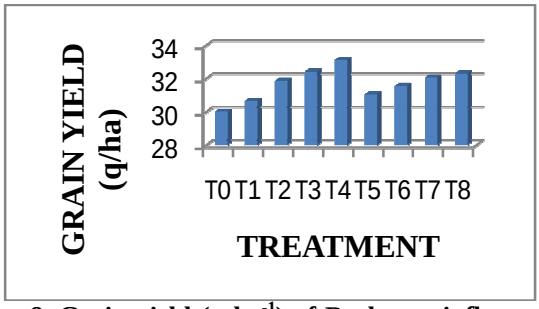

Fig. 8. Grain yield (q ha^{-1}) of Barley as influenced by different levels of inorganic fertilizers under Teak based agrisilviculture system

Straw yield (q/h)

From the table 1 and Fig. 9, it was observed that the Straw yield was significantly influenced by different treatment combinations at different fertilizers levels. At 90 DAS, it was observed that different treatment combination of Straw yield was affect significantly. The maximum Straw yield was found in treatment $T_4$65: 50: 50 i.e. (45.27) followed by treatment $T_3$50: 50: 50 i.e. (43.07) and Straw yield was observed in T_0 control i.e. (38.50).

Harvest index (%)

From the table 1 and Fig. 10, it was observed that the Harvest index was significantly influenced by different treatment combinations at different fertilizers levels. At 90 DAS, it was observed that different treatment combination of Harvest index was affect significantly. The maximum Harvest index was found in treatment T_0 control i.e. (43.82) followed by treatment $T_5$80: 50: 50 i.e. (43.18) and minimum Harvest index was observed in $T_4$65: 50: 50 i.e. (42.26).

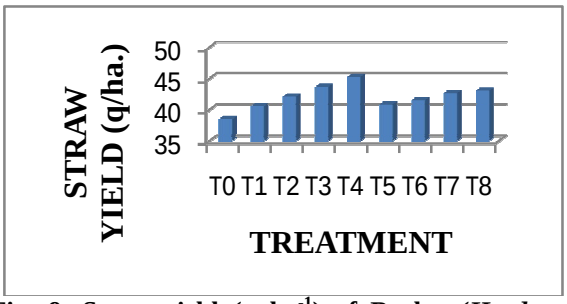

Fig. 9. Straw yield (q ha^{-1}) of Barley (*Hordeum vulgare* L.) as influenced by different levels of inorganic fertilizers under Teak (*Tectona grandis*) based agrisilviculture system

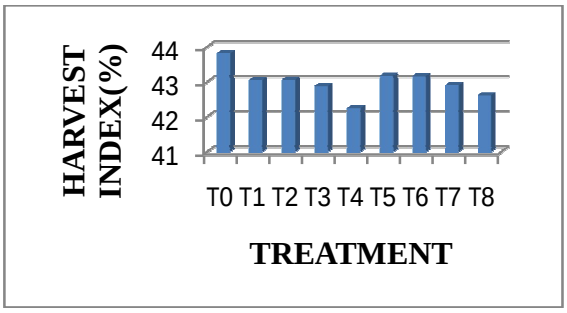

Fig. 10. Harvest index (%) of Barley with different levels of inorganic fertilizers under Teak based agrisilviculture system

Table 1. Effect of different N.P.K fertilizers levels on barley (*Hordeum vulgare* L.) and all growth parameters at 90 DAS under Teak (*Tectona grandis*) at different intervals after sowing

Treatment No. NPK kg/ha	Plant Height (cm)	No. of leaves / Plants	No. of tiller/ hill	No. of spikes / hill	No. of grain/ spike	Length of spike (cm)	Test weight (1000 grain weight) g	Grain yield (q/ ha)	Straw yield (q/ ha)	Harvest Index (%)
T0 control (without fertilizer)	71.87	5.33	5.53	2.47	43.33	9.13	34.32	30.03	38.50	43.82
T1 N:P:K@20:50:50	82.40	7.07	6.93	4.33	46.23	14.20	38.93	30.67	40.56	43.06
T2 N:P:K@35:50:50	83.67	7.40	8.40	5.27	50.57	14.47	40.23	31.88	42.13	43.07
T3 N:P:K@50:50:50	88.30	7.87	9.53	5.93	53.37	14.87	41.47	32.44	43.67	42.62
T4 N:P:K@ 65:50:50	92.20	8.53	10.93	6.87	55.10	15.67	42.73	33.13	45.27	42.26
T5 N:P:K@80:50:50	82.47	7.13	7.27	4.87	47.63	14.27	40.45	31.07	40.88	43.18
T6 N:P:K@95:50:50	83.66	7.33	7.80	5.13	49.97	14.40	40.70	31.57	41.55	43.17
T7 N:P:K@110:50:50	87.53	7.53	8.73	5.47	51.83	14.60	41.20	32.07	42.67	42.91
T8 N:P:K@125:50:50	87.80	7.67	9.13	5.60	52.70	14.73	40.57	32.33	43.07	42.88
S. Ed (+)	0.22	0.05	0.18	0.09	0.26	0.06	0.20	0.11	0.22	0.12
CD (0.05)	0.48	0.11	0.37	0.19	0.55	0.12	0.42	0.22	0.47	0.25

4. Conclusion

Nutrient application of plants can be varied from location to location depending on different factors such as soil and other agro-ecologies. For sustainable production of crops for a particular area, specific fertilizer recommendation is very crucial. For this reason a field experiment was conducted in the Forest nursery and Research centre School of Forestry And Environment. The soil was sandy loam with pH of 7. This experiment was conducted to assess the effect of N.P.K on yield and yield components of barley. The treatments consisted of combination of different levels of N.P.K. The nine treatment combinations were replicated three times in RBD design. Many of the growth and development parameters observed responded to N.P.K fertilization. All the treatment was significantly influenced by N.P.K application. Other parameters, such as, plant height, number of tillers, No. of leaves, No. of tillers, Number of spike, No. of grain spike, Length of spike, Test weight, Grain yield, Straw yield, Harvest index, were significantly increased by N.P.K levels. Therefore, N, P and k fertilizers are very important nutrients in limiting the growth and development of crops which has direct effect on productivity of the crops. The future studies should articulate towards and studies' involving more varies, multi-location and additional rates of N and P application, under Agrisilviculture practices, which may facilitate fine-tuning of fertilizer recommendations. On the basis of above findings, it may be Concluded that the fertilizers level N: P: K @ 65: 50:50 kg/ha. recorded maximum grain yield.

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