

# Effect of organic-inorganic fertilization on yield and yield determining parameters of *Picrorhiza kurroa* Royle ex Benth.: an endangered medicinal plant species of Kashmir Himalaya

## Abstract

*Picrorhiza kurroa* Royle ex Benth (Scrophulariaceae) is a small creeping herbaceous alpine species, used by local and tribal people for curing fever, asthma, jaundice, stomach ache, indigestion, common fever and bronchial asthma. This has resulted in the loss of biodiversity of the species. Roots of *P. kurroa* have been used in traditional medicine for years for treating various kinds of diseases. The species has been ruthlessly harvested from the wild source and has become endangered. Consequently, preventing the species from getting extinct and increasing the yield of *P. kurroa* has become a major concern. In the present investigation, an attempt was made to standardize the cultivation practices using organic manures and inorganic fertilizers in *P. kurroa*. The experiment comprised of 28 treatments (include them here), with three replications each, including one control treatment. The dry root weight recorded by the application of poultry, sheep and farm yard manure was 533.60, 509.60 and 476.70 kg ha<sup>-1</sup>, respectively. Dry root yield increased significantly with increasing levels of phosphorus and nitrogen as well. Application of organic manure and higher levels of inorganic fertilizers resulted in increase in the root weight with maximum with maximum dry root biomass of 640.00 kg ha<sup>-1</sup> was observed in treatment M<sub>1</sub> P<sub>2</sub> N<sub>2</sub> (20 tones of tons of PM, 100 kg P and 150 Kg N ha<sup>-1</sup>) compared to the lowest dry yield of 328.0 kg ha<sup>-1</sup> as observed in control treatment M<sub>0</sub>P<sub>0</sub>N<sub>0</sub> (~~zero~~ zero tones of FYM, 0 kg P and 0 kg N ha<sup>-1</sup>), although the effect of their interaction was non-significant.

**Key words:** *Picrorhiza kurroa*, root weight, organic manure, inorganic fertilizer, yield related parameters

## 1. Introduction

Medicinal plants are the most important source of life saving drugs for the majority of the world's population [21]. They enjoy an inherent and prominent role in general health services of the people. Of the 1814 threatened plant species in India, over 113 taxa occur in Indian

**Comment [EB1]:** Scientific Name of the crop/plant is required for international communication. If this what you used is the scientific name you have to use common name of the crop as well.

**Comment [EB2]:** Add other descriptive for this like the country name

**Comment [EB3]:** Better if you remove this sentence since it is related with the next one.

**Comment [EB4]:** At which rate of these fertilizers does the mentioned values were recorded is required.

**Comment [EB5]:** Better if you add the numerical values instead of the theoretical expression.

**Comment [EB6]:** The conclusion of the experiment and suggestions based on the present finding are missed. So, please add here to make it more complete.

**Comment [EB7]:** Please rearrange these word/phrases in their alphabetical order and remove the words and or the phrases already mentioned/part of the title/.

Himalaya and the list includes *P. kurroa* as an endangered species [9, and 24]. *P. kurroa* Royle ex Benth is a small creeping herbaceous alpine herb. The species is represented by two morphological variants (*viz.* narrow leaf and broad leaf varieties) [9] scarcely occurring between 2,800 to 4,500 meter above mean sea level (amsl). *P. kurroa* yields the drug, picrorhiza, obtained from stolons and roots. It is considered to be a viable bitter tonic, anti-periodic, cholagogue, stomachic, laxative in small doses and cathartic in large doses [9]. In India, the crude drug, Kutaki (*P. kurroa* roots), is being used to treat dyspepsia, respiratory disorders, and diseases of the liver and spleen, including jaundice, cirrhosis, anaemia, hemorrhoids, dermatoses, helminthiasis [2, 13, 14, 17, 26 and 31]. *P. kurroa* is a successful recommendation for restoring various liver-related issues, including anorexia, nausea, jaundice, dyspepsia, viral hepatitis, and periodic fevers. Its root shows antifungal activity by inhibition of the dermatophytic fungi [8, 32, 33 and 34].

**Comment [EB8]:** In my experience citing on source twice in the same paragraph is not acceptable.

A new iridoid, picuroside was isolated from roots of *P. kurroa* (collected from India), together with 3 known iridoids *viz.* picuroside-I, picuroside-II and 6-feruloyl catalpol [10]. Picuroside-I is a major active constituent of picroliv, a hepatoprotective agent [3 and 15]. The effect of picroliv when administered to rats significantly prevented the biochemical changes indicative of liver injury that were associated with aflatoxin B1 toxication [11 and 30]. An alcoholic extract of *P. kurroa* possesses anti-oxidant [6] and anti-diabetic activity [6]. Picrorhiza has also shown to reduce formation of liver cancer due to chemical exposures in animal studies [5]. Picroliv, picuroside-I and kutkoside possess the properties of anti-oxidants [25]. Being a hepatoprotective plant [24] *P. kurroa* has been subjected to heavy collection from the wild due to its ever-increasing demand. Further Anthropogenic activities have impact on physico-chemical properties of plant, water as well as on sediment [27, 28 and 29]. The rate of exploitation of this medicinally important plant species exceeds the rate of regeneration under natural habitat conditions. This implies that immediate measures be adopted for its biodiversity conservation. ~~So~~So, the present study on cultivation practices of the species were carried out at lower altitude using different types of organic manures and inorganic fertilizers in order to investigate their effect on the root biomass ~~and other and other~~ morphological attributes of the ~~plant-plant~~ plant.

**Comment [EB9]:** These sentences /paragraphs contain information about the economic importance of the crop which is too large and should be minimized. it covers more than 50% of the introduction.

## 2. Materials and methods

The experiment was carried out at the Experimental Field of Division of Floriculture, landscape and Architecture, Sher-e-Kashmir University of Agricultural Sciences and Technology Kashmir, Shalimar, Jammu and Kashmir, India. The Soil fertility test of the

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experimental field was done before the planting of the crop (Table 5) [1]. The soil of the experimental field was of clay-loam type. The crop was planted in split-split plot design with three replications each on an area of 400 m<sup>2</sup> which includes main and sub irrigation channels and path in between beds. Organic manures viz. poultry manure (M1, 20 tones ha<sup>-1</sup>), sheep manure (M2, 25 tones ha<sup>-1</sup>) and farmyard manure (M3, 52 tones ha<sup>-1</sup>) were used as the main factors. Nutrient content of each of the manure ~~used~~ ~~was used~~ ~~was~~ also determined (Table 6). Three levels each of phosphorus (P<sub>0</sub> = 0, P<sub>1</sub> = 50 and P<sub>2</sub> = 100 kg ha<sup>-1</sup>) and nitrogen (N<sub>0</sub> = 0, N<sub>1</sub> = 100 and N<sub>2</sub> = 150 kg ha<sup>-1</sup>) were used as sub and sub-sub factors, respectively. Potassium was applied with a constant level of 50 kg ha<sup>-1</sup>. Stolon cuttings were planted in the month of April. Half of the recommended dose of urea (nitrogen source) and the whole dose of diammonium phosphate (phosphorus and nitrogen source) and ~~murat~~ Murat-of-potash (potassium source) were applied at the time of planting. Out of remaining dose of nitrogen, one-fourth dose was applied (in the form of urea) at the time of the first hoeing {(30 days after transplanting (DAT))} and the remaining one-fourth was applied at the time of the 2nd hoeing (64 DAT). Standard package and practices were adopted for raising the healthy crop. Various pre-harvest {(plant height (cm), plant spread (sq. cm), petiole length (cm), number of leaves, leaf area (squared centimeter), number of inflorescences plant<sup>-1</sup>, length of the inflorescence (cm) and number of branches/shoots plant<sup>-1</sup>} and post-harvest {root length plant<sup>-1</sup> (cm), number of roots plant<sup>-1</sup>, diameter of root plant<sup>-1</sup> (cm) and root weight (dry weight of the root) plant<sup>-1</sup>} observations were recorded.

**Statistical analysis:-**The data on various observations collected was subjected to statistical analysis of variance as detailed by Cochran and Cox (1960) for split-split plot design. The significance of the treatment effects was estimated with the help of F-test at 5 and 1% level of significance.

### 3. Results and discussion

#### 3.1 Effect of organic manure on various yield determining characters of *P. kurroa*

Application of organic manure had significantly a ~~positive~~ ~~(positive~~ (p < 0.05) influence on plant height (Table 1). Treatments M<sub>1</sub> and M<sub>2</sub> were at par with each other but treatment M<sub>1</sub> was statistically different from M<sub>3</sub> ~~which~~ ~~which~~ in turn was at par with treatment M<sub>2</sub>. Tallest plants (22.74 cm) were produced in treatment M<sub>1</sub> as compared to ~~smaller sized~~ ~~shortest~~ plants (19.03 cm) in control. Maximum plant spread (407.96 sq.cm plant<sup>-1</sup>) was observed in treatment M<sub>2</sub> and least

**Comment [EB11]:** In my opinion this is part of the result and discussion. Because you have used a combination of organic and inorganic fertilizer and their should be soil analysis after harvest as well for the residual effect and you have to explain it clearly with a supportive literatures.

**Comment [EB12]:** Which years April?

**Comment [EB13]:** These sentences contain the data collected but the way how they were and when does the collection is made? You have to include this information for each parameters including the sample size.

**Comment [EB14]:** I want to put my suggestions here as follows:  
1. You have to portioned the large paragraphs at least by putting the information for each parameter on separate paragraph.  
2. please start you result by the ANOVA result like significance or non-significance for each parameter followed by the maximum and minimum values and the respective treatment which give the parameters value and then the par values. Additionally, do not forget to cite both the ANOVA as well as the mean table on each parameter.  
3. you have to include the justification for each value by taking the treatment that yield that value into account.  
4. The discussion/ comparisons either by supportive or contrasting parafinding of other researchers/authors is also mandatory for accepting your findings.  
5. Please use the above 4 main suggestions/ comments for all the parameters and for the whole result and discussion.

**Comment [EB15]:** Instead of the mean table the ANOVA table should be cited here.

**Comment [EB16]:** It is better if the par values discussion comes after the maximum and minimum values. This comment works for the remaining collected parameters.

(399.77 sq. cm plant<sup>-1</sup>) in treatment M<sub>1</sub>; but the effect was non-significant.

**Comment [EB17]:** The mean table where these values taken should be cited here and this works for the other parameters as well.

**Comment [EB18]:** The reason/justification for this is missed which most important in scientific research and this comment works for the other parameters as well.

**Comment [EB19]:** Where is the numerical value for this parameter. You have to mention here.

**Comment [EB20]:** This should come after the next sentence.

An examination of the data revealed that petiole length was significantly ( $p < 0.01$ ) decreased in treatment M<sub>1</sub> and M<sub>2</sub> with respect to a control. Significantly ( $p < 0.05$ ) higher number of leaves plant<sup>-1</sup> was observed in almost all the treatments with respect to control. Treatment M<sub>1</sub> was statistically different from treatments M<sub>2</sub> and M<sub>3</sub>, while as the latter two treatments were at par with each other. Maximum number of (108.07) leaves plant<sup>-1</sup> was observed in treatment M<sub>1</sub> and the least (84.07 leaves plant<sup>-1</sup>) in control. Treatment M<sub>1</sub> was statistically different from treatments M<sub>2</sub> and M<sub>3</sub>, while as the latter two treatments were at par with each other. Obviously, poultry manure had a greater influence on increasing the number of leaves compared to sheep and farm yard manure. The data with regard to leaf area plant<sup>-1</sup> showed that the maximum leaf area plant<sup>-1</sup> (426.77 sq. cm) was obtained in the treatment M<sub>1</sub> and the least (411.11 sq. cm) in control. However, differences between treatments were non-significant. The data revealed that application of poultry, sheep or farm yard manure did not have any positive effect on increasing the number of inflorescences plant<sup>-1</sup> but instead it remained by and large same in all the three treatments *via*. M<sub>1</sub>, M<sub>2</sub> and M<sub>3</sub> (Table 1). Length of inflorescences was significantly ( $p < 0.01$ ) influenced by the application of organic manure. Treatment M<sub>1</sub> was statistically different from treatment M<sub>2</sub> and M<sub>3</sub> which were at par with each other. Maximum length of inflorescences (6.97 cm plant<sup>-1</sup>) was obtained in treatment M<sub>3</sub> compared to the least length of inflorescences (6.42 cm plant<sup>-1</sup>) observed in treatment M<sub>1</sub>. Data pertaining to effect of organic manure on number of shoots plant<sup>-1</sup> revealed that organic manure had no effect on number of shoots plant<sup>-1</sup> as it had remained by and large same for all the three treatments M<sub>1</sub>, M<sub>2</sub> and M<sub>3</sub> used. Highest of number of 12.33 shoots plant<sup>-1</sup> was observed in treatment M<sub>3</sub> and the least of 12.11 in treatment M<sub>1</sub> (Table 1). Jahan *et al.*[17] also showed that consuming 30 ton/ha manure can increase sub- branches of chamomile (*Matricaria chamomilla* L). The effect of organic manure on dry weight of root was highly significant ( $p < 0.01$ ). All the treatments M<sub>1</sub>, M<sub>2</sub> and M<sub>3</sub> were statistically different from each other. Highest dry weight of root plant<sup>-1</sup> (6.67 g) was obtained in treatment M<sub>1</sub> as compared to the least dry weight of root plant<sup>-1</sup> (5.97 g) observed in control. The difference in dry weight of root plant<sup>-1</sup> between M<sub>1</sub> and M<sub>3</sub> treatments was 0.70 g and between M<sub>1</sub> and M<sub>2</sub> treatments it was only 0.30 g. It seems that the poultry manure had an obvious impact on increasing the dry weight of root plant<sup>-1</sup> compared to sheep or FYM. Maximum root length of 10.18 cm plant<sup>-1</sup> was recorded when poultry manure was incorporated in the soil as compared to sheep manure or FYM. It was observed that organic manure had a highly significant ( $p < 0.01$ ) effect on root

length plant<sup>-1</sup>. Treatment M<sub>1</sub> was statistically different from treatments M<sub>2</sub> and M<sub>3</sub> which were at par with each other. The highest number of 36.81 roots plant<sup>-1</sup> was recorded in treatment M<sub>3</sub> as compared to the least number of 31.77 roots obtained in treatment M<sub>1</sub>. These differences were, however, non-significant. As there were only minor differences in diameter of root plant<sup>-1</sup> among various treatments. However, maximum diameter of 1.14 cm of root plant<sup>-1</sup> was recorded in treatment M<sub>1</sub> and the least of 1.00 cm in control (Table 1). This is because organic matter uptake can increase soil nutrition content and its absorbing capacity and at the same time, it enhances nitrogen equilibrium and phosphorous absorption efficiency [1]. However, the effect was non-significant for plant height, petiole length, number of leaves, inflorescences and number of roots

### 3.1.1 Effect of organic manure on root biomass or dry root yield (kg ha<sup>-1</sup>)

The organic manure comprised of three different manures viz. poultry, sheep and farmyard manure. The dry weight of root was significantly affected by the application of poultry sheep and farmyard manure. All the treatments were statistically different from each other. The dry weight of root recorded by the application of poultry, sheep and farm yard manure was 533.60, 509.60 and 476.70 kg ha<sup>-1</sup>, respectively. Application of poultry manure produced 24.00 and 56.90 kg ha<sup>-1</sup> more yield over the sheep and farm yard manure (Table 2). The increase in root yield was the cumulative effect of the yield attributes (leaf area, number of branches, diameter of root and root length). The high response of *P. kurroa* in terms of root yield may be attributed to additional nutrients supplied through poultry manure. Similar results have also been observed by Nautiyal *et al.* [8] while working with *P. kurroa* wherein they got more yield of root in forest litter treated beds compared to buffalo and sheep manure treated ones.

### 3.2 Effect of phosphorus on various yield determining characters of *P. kurroa*

Phosphorus had a highly significant ( $p < 0.01$ ) effect on plant height. All the treatments were statistically different from each other. Maximum plant height was obtained in treatment P<sub>2</sub> (23.40 cm) compared to the least (18.18 cm) height in control treatment (Table 1). Application of phosphorus @ 50 or 100 Kg ha<sup>-1</sup> showed a highly significant ( $p < 0.01$ ) effect on plant spread. Treatments P<sub>1</sub> and P<sub>2</sub> were at par with each other but were statistically different from control. Highest plant spread (432.25 sq. cm) plant<sup>-1</sup> was observed in treatment P<sub>2</sub> and minimum (356.77 sq. cm) in control. Phosphorus had highly significant ( $p < 0.01$ ) influence on petiole length. Maximum petiole length (1.12 cm leaf<sup>-1</sup>) was recorded for treatment P<sub>1</sub> and the least (0.92 cm) in control. Treatments P<sub>1</sub> and P<sub>2</sub> were at par with each other but were statistically different from control. Perusal of data presented in Table 1, showed that increase in phosphorus had significantly ( $p < 0.01$ ) resulted

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in an increase in number of leaves plant<sup>-1</sup>. Treatments P<sub>1</sub> and P<sub>2</sub> were at par with each other but were statistically different from control. Maximum number of 109.92 leaves plant<sup>-1</sup> was observed in treatment P<sub>2</sub> and the least of 72.37 in control. It was observed that phosphorus had a highly significant (p<0.01) effect on leaf area plant<sup>-1</sup>. Treatments P<sub>1</sub> and P<sub>2</sub> were at par with each other but were statistically different from control. Maximum leaf area of 451.33 sq. cm plant<sup>-1</sup> was observed in treatment P<sub>2</sub> and minimum leaf area of 361.88 sq. cm plant<sup>-1</sup> in control. Significantly (p< 0.01) higher number of inflorescences plant<sup>-1</sup> was observed in almost all the treatments with respect to control. Treatments P<sub>1</sub> and P<sub>2</sub> were at par with each other but were statistically different from a control treatment. Highest number of 10.22 inflorescences plant<sup>-1</sup> was observed in treatment P<sub>2</sub> and the least number of 9.66 inflorescences plant<sup>-1</sup> in control. So it is obvious that lower level of phosphorus is the best optimal level to increase the number inflorescences plant<sup>-1</sup> in the said crop. Highest length of inflorescence of 8.85 cm plant<sup>-1</sup> was observed in treatment P<sub>2</sub> and the least of 4.99 cm in control. Significant increase (p<0.01) in length of inflorescences was observed in all the treatments compared to control. All the treatments P<sub>0</sub>, P<sub>1</sub> and P<sub>2</sub> were statistically different from each other. A positive increase (p < 0.05) in number of shoots plant<sup>-1</sup> was registered with the application of phosphorus. Maximum number of shoots (12.88 plant<sup>-1</sup>) was observed in treatment P<sub>2</sub> and minimum number (10.81 plant<sup>-1</sup>) in control. Treatments P<sub>1</sub> and P<sub>2</sub> were at par with each other but were statistically different from the control. Application of phosphorus had a significant positive (p<0.01) influence on the biomass of roots. Treatments P<sub>1</sub> and P<sub>2</sub> were at par with each other but were statistically different from a control treatment P<sub>0</sub>. The highest dry weight of root (103.20 g plant<sup>-1</sup>) was therefore, observed in treatment P<sub>2</sub> and the least (62.85 g plant<sup>-1</sup>) in control. Highest biomass of 6.88g of root plant<sup>-1</sup> was observed in treatment P<sub>2</sub> and least of 5.67g in control (P<sub>0</sub>). Again reflecting the positive effect of phosphorus on root biomass plant<sup>-1</sup>. The highest root length plant<sup>-1</sup> (9.92cm) was observed in control treatment (P<sub>0</sub>) and the least (8.62 cm) in treatment P<sub>2</sub>. These differences were, however, non-significant. The number of roots produced by the plant varied significantly (p < 0.01) from 27.22 (in P<sub>0</sub>) to 41.25 (in P<sub>2</sub>). All the treatments P<sub>0</sub>, P<sub>1</sub> and P<sub>2</sub> were statistically different from each other and treatment P<sub>2</sub> was superior to all. Significantly (p<0.01) remarkable increase in diameter plant<sup>-1</sup> was observed in all the treatments as compared to control. Treatment P<sub>2</sub> was at par with treatment P<sub>1</sub>, which was at par with treatment P<sub>0</sub>. However, treatment P<sub>0</sub> was statistically different from other treatment P<sub>0</sub>. The highest diameter of root plant<sup>-1</sup> (1.16 cm) was observed in treatment P<sub>2</sub> and the least (0.91 cm) in control (Table 1).

### **3.2.1 Effect of phosphorus on root biomass (kg ha<sup>-1</sup>)**

The dry weight of root increased significantly with every successive level of phosphorus i.e. from 50

to 100 kg ha<sup>-1</sup>. The increase in yield of root due to 50 and 100 kg phosphorus ha<sup>-1</sup> was in the order of 63.20 and 239.20 kg ha<sup>-1</sup>, respectively over 0.0 kg of phosphorus level (control) (Table 3). The root yield obtained at 50 and 100 kg of phosphorus was statistically different from the yield obtained at 0.0 kg phosphorus ha<sup>-1</sup>. The increase in root yield may be due to the positive influence of phosphorus on various yield determining characters (Table 1). As phosphorus is an important part of proteins and phospholipids and might be playing an important role in enhancing the metabolic activities of the plant. Increase in root yield seems to be a reflection of favourable influence of phosphorus on important yield attributes like plant height, plant spread, leaf area, root length and root diameter. Proper nutrition of plants is an important factor in determining their performance. Phosphorus being a macronutrient plays a vital role in plant growth and development [1]. Thus higher phosphorus levels seem to have helped in increasing the crop growth by the improvement of yield attributes. Similar results were obtained by other workers while working with *Salvia miltiorrhiza* [18] and *Rheum australe*[1]. In a similar way, Ombodi and Saigusa (2000) reported that fertilizer treatments improve the nutritional quality of rhubarb. They also reported that the improved nutritional quality in the polyofelin-coated diammonium phosphate (POC-DAP) treatment was a cause of ammonium nutrition rather than a cause of less amount of released nitrogen.

### 3.3 Effect of nitrogen on various yield determining characters of *P. kurroa*

Height of the plants showed a significant ( $p < 0.01$ ) linear increase with increasing levels of nitrogen. All the treatments were statistically different from each other. The highest plant height of 24.25 cm was obtained in treatment N<sub>2</sub> as compared to the least plant height of 17.14 cm in treatment N<sub>0</sub>. There was a significant ( $p < 0.05$ ) increase in plant spread with the increasing levels of nitrogen @ 100 and 150 kg ha<sup>-1</sup>. Treatment N<sub>1</sub> and N<sub>2</sub> were at par with each other but were statistically different from a control treatment P<sub>0</sub>. However, the highest plant spread of 441.40 sq. cm was obtained in treatment N<sub>1</sub> as compared to the least plant spread of 344.44 sq. cm in control (N<sub>0</sub>). The effect of nitrogen was highly significant ( $p < 0.01$ ). All the treatments N<sub>0</sub>, N<sub>1</sub> and N<sub>2</sub> were at par with each other. However, highest petiole length of 1.15cm leaf<sup>-1</sup> was observed in treatment N<sub>2</sub> and least of 0.96cm in treatment N<sub>0</sub> (Table 1). Various levels of nitrogen had a highly significant ( $p < 0.01$ ) effect on increasing the number of leaves plant<sup>-1</sup>. All the treatments were statistically different from each other. Highest number of 115.85 leaves plant<sup>-1</sup> was observed in treatment N<sub>2</sub> and the least of 74.33 leaves plant<sup>-1</sup> in treatment N<sub>0</sub>. Increase in nitrogen resulted in a concomitant increase ( $p < 0.01$ ) in the leaf area plant<sup>-1</sup> (Tables 1). All the treatments were statistically different from each other. Maximum leaf area 511.44 sq .cm plant<sup>-1</sup> was observed in treatment N<sub>2</sub> and minimum leaf area of 313.33 sq .cm plant<sup>-1</sup> in treatment N<sub>0</sub>. An examination of data recorded indicated that nitrogen @ 100 or 150 Kg ha<sup>-1</sup> does not

show any positive effect on number of inflorescences plant<sup>-1</sup> compared to the control. Highest number of 10.33 inflorescences plant<sup>-1</sup> was observed in treatment N<sub>1</sub> and the least number of 9.44 inflorescences plant<sup>-1</sup> in treatment N<sub>0</sub>. Significant increase (p<0.01) in length of inflorescences plant<sup>-1</sup> has been observed in all the treatments compared to control. All the treatments were statistically different from each other. Highest length of inflorescences (6.79 cm) plant<sup>-1</sup> was observed in treatment N<sub>2</sub> and least (5.97 cm) in control treatment N<sub>0</sub>. The data showed a linear increase in number of shoots plant<sup>-1</sup> with increasing levels of nitrogen @ of 100 and 150 Kg ha<sup>-1</sup>. However, the non-significant effect on number of branches plant<sup>-1</sup> was evident from analysis of variance. Maximum number of 12.66 shoots plant<sup>-1</sup> had been observed in treatment N<sub>2</sub> and minimum number of 11.66 shoots in control. Application of nitrogen had a significant positive (p<0.01) influence on the biomass of roots. Treatments N<sub>1</sub> and N<sub>2</sub> were statistically different from each other but the former treatment N<sub>1</sub> was at par with treatment N<sub>0</sub>. Highest biomass of 7.07g of root plant<sup>-1</sup> was observed in treatment N<sub>2</sub> and the least of 5.56 g in treatment N<sub>0</sub>. So increase in the root biomass plant<sup>-1</sup> was the reflection of favorable effect of nitrogen on root biomass plant<sup>-1</sup>. Nitrogen @ 100 and 150 Kg ha<sup>-1</sup> did not show any positive effect on increasing the root length plant<sup>-1</sup> compared to the control. However, maximum root length of 9.44 cm plant<sup>-1</sup> was observed in treatment N<sub>0</sub> and the least of 8.33 cm in treatment N<sub>2</sub>. The effect of nitrogen on number of roots plant<sup>-1</sup> was highly significant (p<0.01). All the treatments N<sub>0</sub>, N<sub>1</sub> and N<sub>2</sub> were statistically different from each other. Maximum number of 39.81 root plant<sup>-1</sup> was observed in N<sub>2</sub> treatment and the least number of 28.33 root plant<sup>-1</sup> in N<sub>0</sub> treatment. Examination of the data showed that diameter of root plant<sup>-1</sup> had markedly increased (p<0.01) with the increase in nitrogen fertilization. Treatments N<sub>1</sub> and N<sub>2</sub> were at par with each other but were statistically different from a control treatment P<sub>0</sub>. Highest diameter of root plant<sup>-1</sup> (1.17 cm) was observed in treatment N<sub>2</sub> and least (0.90 cm) in control treatment N<sub>0</sub> (Table 1). El-Sayed et al. [19] also found that the highest level of nitrogen (300 kg/fed.) on *Echinacea parudoxa* L. significantly improved plant height, fresh and dry weight of herb, fresh and dry weight of whole plant.

### 3.3.1 Effect of nitrogen on root biomass (kg ha<sup>-1</sup>) of *P. kurroa*

The dry weight of root increased significantly with every successive level of nitrogen i.e. from 100 to 150 kg ha<sup>-1</sup>. The increase in yield of root due to 100 and 150 kg nitrogen ha<sup>-1</sup> was in the order of 65.60 and 120.80 kg ha<sup>-1</sup>, respectively over 0.0 kg of nitrogen level (control) (Table 3). The root yield obtained at 50 kg was statistically different from the yield obtained at 100 and 150 kg ha<sup>-1</sup>. Nitrogen, in general, increases the vegetative growth of the plant and thus the plant produces more photosynthates that are deposited in the ultimate sink i.e. roots. The results obtained agreed

with Shaheen *et al.*[12] who showed that, treating *Cynara scolymus* with 100 to 120 kg N/fed as ammonium sulphate gained the best values of fresh and dry weight yield. Increase in the yield is attributable to the vigorous growth of plants with respect to plant height, plant spread and other morphological features at higher level of nitrogen (150 kg ha<sup>-1</sup>) (Table 1); resulting in accumulation of more photosynthates, which are responsible for increasing root yield. Nitrogen being a major constituent of proteins and phospholipids plays a vital role in plant growth and development. Thus higher nitrogen levels have helped in increasing the crop growth and improvement of yield attributes. Similar findings were reported by Rishi *et al.* [4] in *Dioscorea deltoidea*.

### 3.4 Effect of interaction of organic manure, phosphorus and nitrogen on various yield determining characters of *P. kurroa*

Data on the effect of interaction of organic manure, phosphorus and nitrogen on plant height revealed that the maximum plant height of 28.00 cm was observed in treatment M<sub>1</sub>P<sub>2</sub>N<sub>2</sub> compared to the least plant height of 12.00 cm in treatment M<sub>3</sub>P<sub>1</sub>N<sub>0</sub> (Table 2). However, the effect of interaction was non-significant (Table 1). Highest plant spread of 518.33 sq. cm was observed in treatment M<sub>1</sub>P<sub>2</sub>N<sub>2</sub> compared to the least plant spread of 204.66 sq. cm in control treatment M<sub>0</sub>P<sub>0</sub>N<sub>0</sub> (Table 2). But the effect of interaction of organic manure, phosphorus and nitrogen was non-significant (Table 1).

The effect of interaction of organic manure, phosphorus and nitrogen was highly significant ( $p < 0.01$ ) (Table 1). Treatments M<sub>1</sub>P<sub>1</sub>N<sub>1</sub>, M<sub>3</sub>P<sub>1</sub>N<sub>1</sub>, M<sub>2</sub>P<sub>2</sub>N<sub>1</sub> and M<sub>3</sub>P<sub>0</sub>N<sub>2</sub> were at par with each other. But the former two treatments were statistically different from the rest of the twenty three treatments. Highest petiole length of 1.40 cm was observed in two treatments *viz.* M<sub>1</sub>P<sub>1</sub>N<sub>2</sub> and M<sub>3</sub>P<sub>1</sub>N<sub>1</sub> and the least petiole length of 0.60 cm in treatment M<sub>2</sub>P<sub>0</sub>N<sub>0</sub> (Table 2). Data indicate that different organic manures and various levels of phosphorus and nitrogen applied did not influence the number of leaves significantly (Tables 1,2), though maximum number of 143.30 leaves plant<sup>-1</sup> were recorded for M<sub>1</sub>P<sub>2</sub>N<sub>1</sub> and the least number of 50.00 for control treatment (Table 2). The data taken on leaf area plant<sup>-1</sup> showed that leaf area plant<sup>-1</sup> had increased significantly ( $p < 0.01$ ) with the application of organic manure, phosphorus and nitrogen (Tables 1,2). Treatments M<sub>1</sub>P<sub>1</sub>N<sub>2</sub>, M<sub>2</sub>P<sub>2</sub>N<sub>2</sub>, M<sub>1</sub>P<sub>0</sub>N<sub>2</sub>, M<sub>1</sub>P<sub>1</sub>N<sub>1</sub>, M<sub>1</sub>P<sub>2</sub>N<sub>1</sub>, M<sub>1</sub>P<sub>2</sub>N<sub>2</sub>, M<sub>2</sub>P<sub>0</sub>N<sub>2</sub>, M<sub>2</sub>P<sub>1</sub>N<sub>2</sub>, M<sub>3</sub>P<sub>0</sub>N<sub>2</sub>, M<sub>3</sub>P<sub>1</sub>N<sub>2</sub> and M<sub>3</sub>P<sub>2</sub>N<sub>2</sub> were at par with each other but were statistically different from the rest of sixteen other treatments. The highest leaf area of 540.00 sq. cm was observed in two treatments *i.e.*, M<sub>1</sub>P<sub>1</sub>N<sub>2</sub> and M<sub>2</sub>P<sub>2</sub>N<sub>2</sub> compared to the least leaf area of 100.00 sq. cm in treatment M<sub>1</sub>P<sub>0</sub>N<sub>0</sub> (Table 1). Although, the maximum number of 12.00 inflorescences plant<sup>-1</sup> was observed in six treatments *viz.* M<sub>1</sub>P<sub>2</sub>N<sub>1</sub>, M<sub>1</sub>P<sub>2</sub>N<sub>2</sub>, M<sub>2</sub>, M<sub>2</sub>P<sub>1</sub>N<sub>0</sub>, M<sub>2</sub>P<sub>2</sub>N<sub>1</sub>, M<sub>3</sub>P<sub>1</sub>N<sub>2</sub> and M<sub>3</sub>P<sub>2</sub>N<sub>1</sub> compared to the least number of 6.00

**Comment [EB22]:** You have to talk about the interaction effect only when it shows significant result and, in this case, you shouldn't talk about the individual main effects. Thus, please cross check back this. Because in Biometry, interaction effects which show a significance effect only used for the discussion and incases by which the interaction is non-significant the individual main effect is taken and discussion is done based on it. Shortly both the interaction and main effect are not need is significance is observed in the interaction.

inflorescences plant<sup>-1</sup> in the treatment M<sub>1</sub>P<sub>0</sub>N<sub>0</sub> (Table 2), but effect of interaction was non-significant (Table 1). The length of inflorescence plant<sup>-1</sup> had increased significantly (p < 0.01) in maximum number of treatments with respect to control treatment (M<sub>0</sub>P<sub>0</sub>N<sub>0</sub>) (Tables 1,2). Treatment M<sub>3</sub>P<sub>2</sub>N<sub>2</sub> was statistically different from all other treatments. Treatments M<sub>1</sub>P<sub>2</sub>N<sub>2</sub> and M<sub>1</sub>P<sub>2</sub>N<sub>2</sub>, receiving different organic manures i.e. poultry manure and sheep manure but same quantity of phosphorus and nitrogen were at par with each other. Highest length 10.40 cm of inflorescence plant<sup>-1</sup> was observed in treatment M<sub>3</sub>P<sub>2</sub>N<sub>2</sub> compared to the least length of 4.00 cm of inflorescence plant<sup>-1</sup> as observed in treatment M<sub>0</sub>P<sub>0</sub>N<sub>0</sub> (Table 2). Examination of the data on number of shoots plant<sup>-1</sup> revealed that the number of shoots plant<sup>-1</sup> had got increased in all the treatments with respect to control treatment M<sub>3</sub>P<sub>0</sub>N<sub>0</sub> (Table 2). But the effect of interaction was non-significant (Table 1). The highest number of 15.00 shoots plant<sup>-1</sup> were observed in two treatment viz. M<sub>1</sub>P<sub>2</sub>N<sub>1</sub> and M<sub>3</sub>P<sub>1</sub>N<sub>2</sub> as compared to the least number of 9.00 shoots obtained in control treatment M<sub>0</sub>P<sub>0</sub>N<sub>0</sub> (Table 2). Though the maximum dry yield of 8.00 g of root plant<sup>-1</sup> was observed in treatment M<sub>1</sub>P<sub>2</sub>N<sub>2</sub> compared to the minimum dry yield of 4.10 g of root plant<sup>-1</sup> in control treatment M<sub>0</sub>P<sub>0</sub>N<sub>0</sub> (Table 2). However, the effect of interaction was non-significant (Table 1). Poultry, sheep or farm yard manure in combination with higher levels of phosphorus and nitrogen resulted in increased dry yield of root plant<sup>-1</sup>; however poultry manure in combination with higher level of phosphorus and nitrogen showed the highest dry yield of root plant<sup>-1</sup> in contrast to sheep and farm yard manure receiving the same combination of inorganic fertilizers. (Table 2). The effect of interaction on root length plant<sup>-1</sup> was non-significant (Table 1) still the highest root length of 13.33 cm plant<sup>-1</sup> was observed in treatment M<sub>1</sub>P<sub>0</sub>N<sub>0</sub> and the least root length of 6.66 cm plant<sup>-1</sup> was observed treatments M<sub>3</sub>P<sub>0</sub>N<sub>1</sub> (Table 2). It is evident from the table 2 that poultry manure alone or in combination with lower or higher levels of phosphorus (50 or 100 kg ha<sup>-1</sup>) and nitrogen (100 or 150 kg ha<sup>-1</sup>) or either with only lower or higher levels of phosphorus (50 or 100 kg ha<sup>-1</sup>) or nitrogen (100 or 150 kg ha<sup>-1</sup>) produced a greater length of roots. This is in contrast to sheep manure (25 tones ha<sup>-1</sup>) or farm yard manure (25 tones ha<sup>-1</sup>) receiving the same combination of inorganic fertilizers. Maximum number of 55.33 roots plant<sup>-1</sup> was recorded in treatment M<sub>1</sub>P<sub>2</sub>N<sub>2</sub> compared to the least number of 23.00 roots plant<sup>-1</sup> in treatment M<sub>3</sub>P<sub>0</sub>N<sub>0</sub> (Table 2). Number of roots was increased in all treatments with respect to control treatment (M<sub>3</sub>P<sub>0</sub>N<sub>0</sub>). However, differences among treatments were non-significant (Table 1). Diameter of root plant<sup>-1</sup> had got increased in all treatments with respect to control (Table 2). Though, the effect of interaction of organic manure, phosphorus and nitrogen was non-significant (Table 1). Moreover, the highest diameter of 1.40 cm of root plant<sup>-1</sup> was obtained in treatment M<sub>1</sub>P<sub>2</sub>N<sub>2</sub> compared to the least diameter of 0.48 cm of root plant<sup>-1</sup> as observed in treatment M<sub>0</sub>P<sub>0</sub>N<sub>0</sub>.

### 3.3.1 Effect of interaction of organic manure, phosphorus and nitrogen on root yield or root weight (kg ha<sup>-1</sup>) of *P. kurroa*

The highest dry yield of 640.00 kg ha<sup>-1</sup> was observed in treatment M<sub>1</sub>P<sub>2</sub>N<sub>2</sub> compared to the lowest dry yield of 344.00 kg ha<sup>-1</sup> as observed in control treatment M<sub>3</sub>P<sub>0</sub>N<sub>0</sub> (Table 4). However, the effect of interaction of organic manure, phosphorus and nitrogen was non-significant as depicted from analysis of variance (Table 1). Poultry, sheep or farm yard manure when in combination with higher levels of phosphorus (100 kg ha<sup>-1</sup>) and nitrogen (150 kg ha<sup>-1</sup>) had resulted in increased dry yield of root plant<sup>-1</sup>, however poultry manure in combination with higher level of phosphorus and nitrogen showed the highest dry yield of root plant<sup>-1</sup> in contrast to sheep and farm yard manure receiving the same combination of inorganic fertilizers. Further a trend was seen that when poultry manure was used in combination with lower or higher levels of phosphorus (50 or 100 kg ha<sup>-1</sup>) and/or nitrogen (100 or 150 kg ha<sup>-1</sup>) produced a greater dry yield of root plant<sup>-1</sup> in contrast to sheep manure or farm yard manure receiving the same combination of inorganic fertilizers (Table 4). Increase in root yield seems to be a reflection of favourable influence of organic manure and inorganic fertilizers on important yield attributes like plant height, plant spread and leaf area [1].

## 4. Conclusion

Cultivation of economically important plant revealed that the highest dry weight of root (692.80 kg ha<sup>-1</sup>) in *P. kurroa* was obtained by the application of phosphorus @ 100 kg ha<sup>-1</sup> as compared to various organic manures or/different levels of nitrogen used. Among the organic manures used viz. poultry, sheep and farmyard manure, the highest root biomass of 33.60 kg ha<sup>-1</sup> was recorded by the application of poultry manure. *P. kurroa* species in Kashmir Himalayan region is endangered because of various biotic and abiotic stresses. Further, the species is a high value crop and has high commercial demand. Hence it's over exploitation by man continues at an alarming rate. This necessitates its immediate conservation measures to protect the species from extinction.

## Conflicts of Interests

The authors have not declared any conflict of interests

**Comment [EB23]:** It is too short and incomplete. Thus revise it.

**Table -1: Effect of organic manure, phosphorus and nitrogen on various morphological characters of *Picrorhiza kurroa***

Character	Main treatment (M)				Sub treatment (P)				Sub-sub treatment (N)			
	M <sub>1</sub>	M <sub>2</sub>	M <sub>3</sub>	LSD (5%)	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	LSD (5%)	N <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>	LSD (5%)
Plant height (cm)	22.74	20.62	19.03	2.50*	18.18	20.81	23.40	1.43**	17.14	21.00	24.25	1.64**
Plant spread (sq. cm)	399.77	407.96	401.88	NS	356.77	420.59	432.25	27.17**	344.44	441.40	423.77	49.11**
Petiole length leaf <sup>-1</sup> (cm)	1.07	0.97	1.11	0.06**	0.92	1.12	1.11	0.10**	0.96	1.04	1.15	0.06**
No. of leaves plant <sup>-1</sup>	108.07	87.00	84.07	14.72**	72.37	96.85	109.92	14.23**	74.33	88.96	115.85	14.50**
Leaf area plant <sup>-1</sup> (sq. cm)	426.77	420.33	411.11	NS	361.88	445.00	451.33	39.54**	313.33	433.44	511.44	25.35**
No. of inflorescence plant <sup>-1</sup>	9.66	10.11	10.22	NS	8.6666	10.66	10.66	1.17**	9.44	10.33	10.22	NS
Length of inflorescence (cm)	6.42	6.96	6.97	0.02**	4.99	6.51	8.85	0.08**	5.97	6.79	7.58	0.07**
No. of shoots plant <sup>-1</sup>	12.11	12.25	12.33	NS	10.81	13.00	12.88	1.24**	11.66	12.37	12.66	NS
Root Biomass/Dry weight of root plant <sup>-1</sup> (g)	6.67	6.37	5.97	0.27**	5.67	6.46	6.88	0.55**	5.56	6.38	7.07	0.66**
Root length plant <sup>-1</sup> (cm)	10.18	8.37	8.29	1.50*	9.92	8.29	8.62	NS	9.44	9.07	8.33	NS
No. of roots plant <sup>-1</sup>	36.81	34.55	31.77	NS	27.22	34.66	41.25	3.12**	28.33	35.00	39.81	4.21**
Diameter of root plant <sup>-1</sup> (cm)	1.14	1.00	1.01	NS	0.91	1.07	1.16	0.17*	0.90	1.07	1.17	0.15**

{Poultry manure (M1) (20 tones ha<sup>-1</sup>), sheep manure (M2) (25 tones ha<sup>-1</sup>) and farmyard manure (M3) (25 tones ha<sup>-1</sup>): Phosphorus (P0=0, P1= 50 and P2= 100 kg ha<sup>-1</sup>) and Nitrogen (N0 = 0, N1 = 100 and N2 = 150 kg ha<sup>-1</sup>): LSD = Least significant difference, Non-significant (ns) , \*Significant at 5% level, \*\*Significant at 1% level.

**Comment [EB24]:** I have a general comment regarding the tables: Please take this and the other tables and put under the discussion and result part mainly after the paragraphs which deals about the parameters the tables contain. Because this is the main finding not supplementary.

**Table 2: Effect of interaction of organic manure, phosphorus and nitrogen on various morphological characters of *Picrorhiza kurroa***

S. No.	Treatment	Plant height(cm)	Plant spread (sq.cm)	Petiole length leaf <sup>1</sup> (cm)	No. of leaves plant <sup>-1</sup>	Leaf area plant <sup>-1</sup> (sq. cm)	No. of Inf. plant <sup>-1</sup>
1.	M <sub>1</sub> P <sub>0</sub> N <sub>0</sub>	18.33	229.66	0.96	63.00	100.00	6.000
2.	P <sub>0</sub> N <sub>1</sub>	18.00	408.00	0.80	83.33	418.00	8.000
3.	P <sub>0</sub> N <sub>2</sub>	21.33	354.33	1.20	110.0	524.00	10.00
4.	P <sub>1</sub> N <sub>0</sub>	20.33	404.00	1.10	92.00	380.00	11.00
5.	P <sub>1</sub> N <sub>1</sub>	24.33	439.66	0.90	98.00	490.00	10.00
6.	P <sub>1</sub> N <sub>2</sub>	27.00	380.00	1.40	135.0	540.00	9.000
7.	P <sub>2</sub> N <sub>0</sub>	21.33	396.00	1.20	102.0	400.00	9.000
8.	P <sub>2</sub> N <sub>1</sub>	26.00	468.00	1.10	143.3	505.00	12.00
9.	P <sub>2</sub> N <sub>2</sub>	28.00	518.33	1.00	146.0	484.00	12.00
10.	M <sub>2</sub> P <sub>0</sub> N <sub>0</sub>	14.66	243.00	0.60	50.00	270.00	9.000
11.	P <sub>0</sub> N <sub>1</sub>	17.33	430.66	080	65.00	360.00	8.000
12.	P <sub>0</sub> N <sub>2</sub>	22.66	419.66	0.89	90.00	490.00	11.00
13.	P <sub>1</sub> N <sub>0</sub>	14.00	395.00	1.10	80.00	360.00	12.00
14.	P <sub>1</sub> N <sub>1</sub>	21.33	466.00	0.80	90.00	450.00	11.00
15.	P <sub>1</sub> N <sub>2</sub>	25.33	447.00	1.20	115.0	510.00	10.00
16.	P <sub>2</sub> N <sub>0</sub>	19.00	406.33	1.10	68.00	350.00	9.000
17.	P <sub>2</sub> N <sub>1</sub>	24.00	429.66	1.30	100.0	453.00	12.00
18.	P <sub>2</sub> N <sub>2</sub>	27.33	434.33	1.00	125.0	540.00	9.000
19.	M <sub>3</sub> P <sub>0</sub> N <sub>0</sub>	16.66	204.66	0.70	55.00	280.00	7.000
20.	P <sub>0</sub> N <sub>1</sub>	16.00	481.00	1.10	60.00	345.00	10.00
21.	P <sub>0</sub> N <sub>2</sub>	18.66	440.00	1.30	75.00	470.00	9.000
22.	P <sub>1</sub> N <sub>0</sub>	12.00	420.66	1.00	65.00	320.00	11.00
23.	P <sub>1</sub> N <sub>1</sub>	20.00	435.33	1.40	70.00	430.00	10.00
24.	P <sub>1</sub> N <sub>2</sub>	23.00	397.66	1.20	126.6	525.00	12.00
25.	P <sub>2</sub> N <sub>0</sub>	18.00	400.66	0.90	94.00	360.00	11.00
26.	P <sub>2</sub> N <sub>1</sub>	22.00	414.33	1.20	91.00	450.00	12.00
27.	P <sub>2</sub> N <sub>2</sub>	25.00	422.66	1.20	120.0	520.00	10.00
28.	M <sub>0</sub> P <sub>0</sub> N <sub>0</sub>	12.10	205.00	0.63	50.00	150.00	7.00
	LSD (5%)	NS	NS	0.19**	NS	76.05**	NS

Inf. =Inflorescence

Table 30: Contd....

**Comment [EB25]:** Please portioned this large and difficult table in to different and understandable table by collecting parameters based on their type. For Example, prepare one table for growth parameters, the other for yield determining parameters and the third yield parameters. This will make it either to understand attractive.

**Table 2: Contd...**

S. No.	Treatment	Length of Inf. plant <sup>-1</sup>	No. of shoots plant <sup>-1</sup>	Root biomass plant <sup>-1</sup> (g)	Root length plant <sup>-1</sup> (cm)	No. of roots plant <sup>-1</sup>	Diameter of root plant <sup>-1</sup> (cm)
1.	M <sub>1</sub> P <sub>0</sub> N <sub>0</sub>	4.20	09.10	5.0	13.33	0.80	0.80
2.	P <sub>0</sub> N <sub>1</sub>	4.80	10.00	6.0	13.00	1.00	1.00
3.	P <sub>0</sub> N <sub>2</sub>	5.30	14.00	7.0	11.00	1.30	1.30
4.	P <sub>1</sub> N <sub>0</sub>	5.00	14.00	6.1	7.330	0.99	0.99
5.	P <sub>1</sub> N <sub>1</sub>	6.80	13.00	7.0	10.66	1.10	1.10
6.	P <sub>1</sub> N <sub>2</sub>	6.60	11.00	7.4	08.33	1.30	1.30
7.	P <sub>2</sub> N <sub>0</sub>	7.19	10.00	6.4	08.00	1.20	1.20
8.	P <sub>2</sub> N <sub>1</sub>	8.09	15.00	7.2	12.00	1.20	1.20
9.	P <sub>2</sub> N <sub>2</sub>	9.80	14.00	8.0	8.000	1.40	1.40
10.	M <sub>2</sub> P <sub>0</sub> N <sub>0</sub>	5.10	11.00	4.8	11.66	0.70	0.70
11.	P <sub>0</sub> N <sub>1</sub>	4.90	10.33	5.7	7.000	0.90	0.90
12.	P <sub>0</sub> N <sub>2</sub>	4.93	12.00	6.8	8.000	1.00	1.00
13.	P <sub>1</sub> N <sub>0</sub>	5.60	14.00	5.9	9.000	0.89	0.89
14.	P <sub>1</sub> N <sub>1</sub>	6.40	13.00	6.5	8.330	1.00	1.00
15.	P <sub>1</sub> N <sub>2</sub>	8.20	13.00	7.1	7.660	1.10	1.10
16.	P <sub>2</sub> N <sub>0</sub>	8.10	12.00	6.1	7.000	0.90	0.90
17.	P <sub>2</sub> N <sub>1</sub>	9.40	14.00	7.0	8.660	1.20	1.20
18.	P <sub>2</sub> N <sub>2</sub>	10.0	11.00	7.5	8.000	1.30	1.30
19.	M <sub>3</sub> P <sub>0</sub> N <sub>0</sub>	5.50	09.00	4.3	10.33	0.60	0.60
20.	P <sub>0</sub> N <sub>1</sub>	5.03	12.00	5.2	6.660	0.90	0.90
21.	P <sub>0</sub> N <sub>2</sub>	5.20	11.00	6.3	8.330	1.00	1.00
22.	P <sub>1</sub> N <sub>0</sub>	5.30	13.00	5.5	9.000	1.10	1.10
23.	P <sub>1</sub> N <sub>1</sub>	6.90	11.00	6.2	7.000	1.20	1.20
24.	P <sub>1</sub> N <sub>2</sub>	7.80	15.00	6.5	7.330	1.00	1.00
25.	P <sub>2</sub> N <sub>0</sub>	7.80	14.00	6.0	9.330	0.90	0.90
26.	P <sub>2</sub> N <sub>1</sub>	8.79	13.00	6.7	8.330	1.20	1.20
27.	P <sub>2</sub> N <sub>2</sub>	10.4	13.00	7.1	8.330	1.20	1.20
28.	M <sub>0</sub> P <sub>0</sub> N <sub>0</sub>	4.00	09.00	4.1	8.23	0.48	0.48
	LSD (5%)	0.20**	NS	NS	NS	NS	NS

{Poultry manure (M1) (20 tones ha-1), sheep manure (M2) (25 tones ha-1) and farmyard manure (M3) (25 tones ha-1), phosphorus (P0=0, P1= 50 and P2= 100 kg ha-1) and nitrogen (N0 = 0, N1 = 100 and N2 = 150 kg ha-1): LSD = Least significant difference, non-significant (ns), \*Significant at 5% level, \*\*Significant at 1% level.}

**Table 3. Yield of economic part as affected by organic manure phosphorus and nitrogen in *P. kurroa***

S/N	Treatment	Root weight m <sup>-2</sup> (g)	Root weight (kg ha <sup>-1</sup> )
1	M <sup>1</sup>	53.36	533.6
2	M <sup>2</sup>	50.96	509.6
3	M3	47.76	477.6
4	P0	45.36	453.6
5	P1	51.68	516.8
6	P2	55.04	550.4
7	N0	44.48	444.8
8	N1	51.04	510.4
9	N2	56.56	565.6

Poultry manure (M1) (20 tones ha<sup>-1</sup>), sheep manure (M2) (25 tones ha<sup>-1</sup>) and farmyard manure (M3) (25 tones ha<sup>-1</sup>) phosphorus (P0=0, P1= 50 and P2= 100 kg ha<sup>-1</sup>) and nitrogen (N0= 0, N1= 100 and N2= 150 kg ha<sup>-1</sup>).

**Table 4. Yield of economic part as affected by interaction of organic manure, phosphorus and nitrogen in *Picrorhiza kurroa*.**

S/N	Treatment	Root weight m <sup>-2</sup> (g)	Root weight (kg ha <sup>-1</sup> )
1.	M <sub>1</sub> P <sub>0</sub> N <sub>0</sub>	40.0	400.0
2.	P <sub>0</sub> N <sub>1</sub>	48.0	480.0
3.	P <sub>0</sub> N <sub>2</sub>	56.0	560.0
4.	P <sub>1</sub> N <sub>0</sub>	48.8	488.0
5.	P <sub>1</sub> N <sub>1</sub>	56.0	560.0
6.	P <sub>1</sub> N <sub>2</sub>	59.2	592.0
7.	P <sub>2</sub> N <sub>0</sub>	51.2	512.0
8.	P <sub>2</sub> N <sub>1</sub>	57.6	576.0
9.	P <sub>2</sub> N <sub>2</sub>	64.0	640.0
10.	M <sub>2</sub> P <sub>0</sub> N <sub>0</sub>	38.4	384.0
11.	P <sub>0</sub> N <sub>1</sub>	45.6	456.0
12.	P <sub>0</sub> N <sub>2</sub>	54.4	544.0
13.	P <sub>1</sub> N <sub>0</sub>	47.2	472.0
14.	P <sub>1</sub> N <sub>1</sub>	52.0	520.0
15.	P <sub>1</sub> N <sub>2</sub>	56.8	568.0
16.	P <sub>2</sub> N <sub>0</sub>	48.8	488.0
17.	P <sub>2</sub> N <sub>1</sub>	56.0	560.0
18.	P <sub>2</sub> N <sub>2</sub>	60.0	600.0
19.	M <sub>3</sub> P <sub>0</sub> N <sub>0</sub>	34.4	344.0

20.	P <sub>0</sub> N <sub>1</sub>	41.6	416.0
21.	P <sub>0</sub> N <sub>2</sub>	50.4	504.0
22.	P <sub>1</sub> N <sub>0</sub>	44.0	440.0
23.	P <sub>1</sub> N <sub>1</sub>	49.6	496.0
24.	P <sub>1</sub> N <sub>2</sub>	52.0	520.0
25.	P <sub>2</sub> N <sub>0</sub>	48.0	480.0
26.	P <sub>2</sub> N <sub>1</sub>	53.6	536.0
27.	P <sub>2</sub> N <sub>2</sub>	56.8	568.0
28.	M <sub>0</sub> P <sub>0</sub> N <sub>0</sub>	32.8	328.0

Poultry manure (M1) (20 tones ha-1), sheep manure (M2) (25 tones ha-1) and farmyard manure (M3) (25 tones ha-1) phosphorus (P0=0, P1 = 50 and P2 = 100 kg ha-1) and nitrogen (N0 = 0, N1 = 100 and N2 = 150 kg ha-1).

**Table 5: Soil fertility status of the experimental field**

Parameters	Value
pH (1:2.5)	7.02
E.C(1:2.5) dsm <sup>-1</sup>	0.22
Organic matter	2.4%
Available N (kg ha <sup>-1</sup> )	213.0
Available P(kg ha <sup>-1</sup> )	71.0
Available K(kg ha <sup>-1</sup> )	263.0
Available S (kg ha <sup>-1</sup> )	40.0
Calcium (Meq)	11.0
Magnesium (Meq)	2.0

**Comment [EB26]:** What is the importance of the two tables? Use either of the two based on the comments given above. If the interaction shows significance use it if not use the main effects table only.

**Comment [EB27]:** This table should be the first part of the results and discussion part of the manuscript and should have a proper discussion and interpretation. You have to do this one.

**Table 6. Nutrient content of FYM, sheep and poultry manure.**

Parameter	Farm yard manure	Sheep manure	Poultry manure
pH(1:2.5)	7.19	7.0	6.5
Moisture content%	71.0	63.0	48.26
Organic matter%	35.25	39.63	40.11
N %	1.35	1.48	2.29
P <sub>2</sub> O%	0.18	0.36	1.70
K <sub>2</sub> O%	0.13	0.19	1.11
S %	0.03	0.04	0.6
Calcium oxide%	0.10	0.42	2.37
Magnesium oxide%	0.13	0.12	0.67

**Comment [EB28]:** This table should come under the materials and method part of the manuscript

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