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# Growth analysis of soybean varieties under different land configurations in mollisols of Himalayan *Tarai*

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**Abstract**
Despite availability of numerous high yielding varieties of soybean, the average grain yield is still low in India owing to its poor growth due to factors like untimely sowing, low seed viability, poor soil fertility, poor drainage, weed infestation, pest and disease attack etc. Land configuration decides the effectiveness of the crop management practices regarding application of nutrient, irrigation, weed management etc and can play a major role in better growth of soybean. The present study was thus planned to analyse the growth of soybean varieties under different land configurations in mollisols of himalayan *tarai*. The experiment was conducted during the *kharif* season of 2017, in C5 block of N.E. Borlaug Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar (Uttarakhand). Treatments consisted of three land configurations ( Flat bed, ridge and furrow and raised bed) and varieties (PS-1092, PS-1225 and PS-1347) were set out in split plot design keeping land configurations in main plot and varieties in sub plot with three replication. The soil of experimental site was sandy loam in nature having medium soil organic carbon, low in available nitrogen but high in available phosphorus and medium potassium contents. Soybean was planted on 18 July, 2017 at a spacing of 45cmx10cm and harvested on 16 November, 2017. Under different land configurations, emergence count at 10th day after sowing, number of trifoliate leaves, stem dry weight and crop growth rate were found to be significantly affected but there was no significant effect on the plant height, canopy spread, leaf dry weight, total plant dry weight, leaf: stem ratio of soybean. Varieties also did not show any significant effect on emergence of soybean however plant height, number of trifoliate leaves, leaf dry weight, stem weight, total plant dry matter, root dry weight and growth rate differed significantly. The study revealed that better selection of variety and land configuration may lead to positive effect on soybean growth which in turn would result in better yield.

**Keywords:** Land configuration, flat bed, ridge and furrow, raised bed, crop growth rate, trifoliate leaves

## Introduction
Soybean [*Glycine max* (L.) Merrill] is basically a legume crop, but has established its potential as a major oilseed crop in the world, accounting for more than 50 percent of oilseed produced and 30 percent of the total supply of all vegetable oils. Despite availability of numerous high yielding varieties of soybean, the average grain yield is still low in India. Factors responsible for low yield of soybean include untimely sowing, low seed viability, poor soil fertility, poor drainage, weed infestation, pest and disease attack etc. In northern India, soybean is taken during *Kharif* rainy season (June-November). The excess moisture or water logging conditions during monsoon season create unfavourable conditions for growth, such as reduced porosity which in turn reduces soil aeration, reduced root growth, hampered nodulation, reduced nutrient uptake affecting the physiology and biochemistry of a plant adversely which ultimately reflects on its productivity. Land management system plays a major important role in minimizing soil erosion and improving water use efficiency of field crops. Easy and uniform germination as well as growth and development of plant are provided by manipulation of sowing method. Land configuration increases water use efficiency and also increases availability of nutrients to crops (Chiroma *et al.*, 2008) [1]. The adoption of proper land configuration system will help in increasing income of farmers besides preventing land degradation due to runoff erosion (Dwivedi *et al*., 2002) [4]. Dhakad *et al*. (2014) [3] found higher growth and yield attributes of soybean in ridge and furrow system compared to the flat bed sowing which subsequently resulted in yield enhancement to the extent of 27.2 percent. Ralli and Dingra (2003) [7] reported higher growth rates of soybean in case of ridge and furrow because of less stagnation of water due to furrow and proper aeration due to ridges leading to satisfactory physical environment for plant growth. Jadhav *et al.* (2011) [5] studied effect of mechanized land configuration on growth and growth attributes of soybean in a clayey soil. The plant height, number of branches per plant and dry matter accumulation per plant was recorded maximum in broad bed furrow method followed by the ridges and furrow method.

Devrat *et al.* (2012) [2] reported that the planting of soybean on furrow irrigated raised bed system (FIRBs) resulted in significantly higher plant population than on normally adopted flat bed. In Madhya Pradesh, Dhakad *et al*. (2014) [3] compared soybean crop on ridge and furrow system with flat-bed sowing at f armer's fields.

Development of new varieties of a crop is a regular phenomenon. Different cultivars of soybean are sensitive to change in environmental conditions where the crop is being grown. It was found that soybean genotype JS95-60, JS97-52, Bhat, Cat3299 and JS 93-05 possessed relatively better growth attributes and tolerance to water logging as compared to other genotypes out of total 50 genotypes tested. **Khubele** and Nema (2015) [6] reported that the soybean variety RVS 2001-4 recorded significantly higher plant population, plant height, number of branches per plant, root length, dry weight of roots than variety JS 95-60. At Pantnagar (Uttarakhand) Vandana *et al.* (2017) studied 12 varieties of soybean and found significant differences among the varieties for characters such as number of primary branches/plant, plant height.

Therefore, it is important to study the genotype and land configuration interaction to identify the varieties which are stable in different planting techniques. The present study was thus planned with the objective to analyse the growth of soybean varieties under different land configurations in mollisols of Himalayan *tarai.*

## Materials and Methods

The field experiment was conducted in *Kharif* season of 2017 in C5 block at the Norman E. Borlaug Crop Research Centre of Govind Ballabh Pant University of Agriculture & Technology, Pantnagar (U.S. Nagar), Uttarakhand, India. Geographically, Pantnagar is situated in the *Tarai* area which is narrow belt in the foothills of Shivalik range of Himalayas at 29°N latitude and 79.5°E longitude and at an altitude of 243.8m above mean sea level. The experimental soil was low in available nitrogen, medium in organic carbon but high in phosphorus and medium in potassium. The experiment was conducted in split plot design with 3 land configurations (Flat sowing, Ridge and furrow sowing and Raised bed sowing) in main plot and 3 varieties of soybean (PS -1092, PS -1225 and PS -1347) in sub-plot.

In flat sowing soybean was sown in rows open 45 cm apart. Land configuration viz., ridge and furrow and raised beds were made manually with small spade. Distance between center to center of furrows was 45cm in ridge and furrow system. One row of soybean was sown on the ridge. In raised bed system, distance between center to center of furrows was 90cm. Two rows of soybean were sown on a bed at 30cm apart. Thinning was done between 20-22 days after sowing (DAS) to maintain spacing between 10±2 cm.

Varieties tested were: PS-1092- purple flowers, yellow seed colour with black hilum colour, tawny pubescence, determinate growth type, pod colour is brown, spherical seed shape, short plant height, erect growth habit with pointed ovate leaf shape. The duration of its growth is 118-120 days. Recommended for *tarai* and *bhabar* region of UP, Uttarakhand and upto mid hills of Uttarakhand. PS-1225 - white flowers, yellow seed colour with brown hilum colour, grey pubescence, semi-determinate growth type, pod colour is yellow, spherical seed shape, medium plant height, semi-erect growth habit with pointed ovate leaf shape. PS-1347 - white flowers, yellow seed colour with brown hilum colour, tawny pubescence, determinate growth type, pod colour is brown, elliptical seed shape, short plant height, semi-erect growth habit with lanceolate leaf shape. The duration of its growth is 120-125 days. The suitable areas of its cultivation are Northern Plain Zone, UP, UK, Delhi, Punjab, etc

## Results and Discussion

### Growth parameters

### Emergence count

Data pertaining to emergence count and plant height of soybean is given in Table 1. Emergence count was recorded on 10th day after sowing before thinning. The maximum emergence of soybean was recorded in ridge & furrow method of sowing followed by raised bed method. Both the land configuration, i.e. ridge & furrow and raised bed were at par but significantly higher than flatbed method. The increase in emergence count could be due to loosening of soil in ridging compared to conventional sowing in flatbed. With respect to varieties there was no significant difference in emergence count and all three varieties exhibited more or less similar emergence count. The non-significant difference among varieties for emergence count may be attributed to use of certified seeds, having minimum standard germination i.e. more than 80 percent.

### Plant height

The height of soybean plants increased progressively with the advancement of crop age. The plant height increased at 0.75 cm/day upto 40 days after sowing (DAS). Thereafter, momentum changed and plant height increased at 0.46cm/day. At both the stages of determination the height of soybean plants was not affected significantly by different land configurations. However, relatively taller plants were observed in raised bed method, this might be due to inter- row competition between rows as raised bed have closer row spacing. Non-significant variation among sowing methods, implies that the vertical growth of plants was not affect by variable establishment methods. At 40 DAS, plant height of var. PS-1092 was significantly higher than other two varieties and var. PS-1347 recorded with the lowest plant height. At 80 DAS, varieties PS-1092 and PS-1225 was at par but had significantly higher plant height than PS-1347. The variation in plant height among varieties may be because of variable genotypic make up of different varieties. This implies that increase in grain yield on selection of taller soybean genotypes would not be rewarding.

### Number of trifoliate leaves per plant

The data pertaining to number of trifoliate leaves and canopy spread of soybean is given in Table 2. The number of trifoliate leaves increased with advancement in crop age. The number of trifoliate leaves increased at a rate of 1.24 and 2.5 per plant between 0-40 DAS and 40-80 DAS, respectively. The higher rate of increase between 40-80 DAS period may be owing to coinciding of this period with rapid growth phase of the crop. The number of trifoliate leaves per plant was not affected significantly by land configuration at 40 DAS, though numerically the highest number of trifoliate leaves was found in ridge & furrow method. At 80DAS, the number of trifoliate leaves was significantly higher in ridge & furrow method than flat bed and raised bed, which were at par to each other. Better growing environment owing to proper drainage in ridge planting than flat sowing might have helped the soybean crop to produce more leaves. Although raised bed method of sowing also provided almost similar environment, but probably due to inter rows competition on bed the impact on number of trifoliate leaves was less visible. With respect to varieties at 40 DAS, variety PS-1092 and PS-1225 recorded significantly higher number of trifoliate leaves than PS-1347 (11/plant) but were at par to each other. At 80 DAS, the number of trifoliate did not vary significantly between varieties PS-1092 and PS-1347. At this stage, variety PS-1225 produced the significantly highest number of trifoliate (25/plant). Remaining two varieties were at par for number of trifoliate/plant. The variation in number of trifoliate may be attributed to variation in genetic potential to produce leaves, as the other management factors were identical for all the varieties.

**Canopy spread**

As soybean is bushy type crop, its canopy spread increased with advancement of crop age as the growth of stems and leaf increased. Canopy spread was not significantly influenced both due to land configurations and varieties. Numerically ridge & furrow method showed the maximum canopy spread than other two land configurations. Similarly, in case of varieties also, there was no significant difference recorded, at 40 DAS canopy spread was almost same but at 80 DAS var. PS 1347 recorded slightly lower canopy spread.

**Dry matter accumulation**

The data pertaining to number of dry matter accumulation and leaf: stem ratio of soybean is given in Table 3. Dry matter accumulation in leaves of soybean plant increased with advancement of crop age. The leaf dry weight increased at 0.19 g/day upto 40 DAS and then from 40 to 80 DAS, it increased at 0.18 g/day. More or less dry matter in leaves increased at a constant rate during two growth periods. Land configurations showed no significant difference in leaf dry weight. Varieties showed significant difference in leaf dry matter at 40 as well as 80 DAS. Variety PS-1225 was found to be significantly higher in terms of leaf dry weight at 40 and 80 DAS than other two varieties. The stem dry weight increased with at 0.13 g/day upto 40 DAS. At 80 DAS, reproductive growth was started, which contributed some pod dry weight also to stem dry weight, therefore 80 DAS data includes dry weight of stem plus pods. From 40 to 80 DAS stem dry weight increase at a rate of 0.47 g/day. Among land configurations, at 40 DAS there was no significant difference observed in stem dry weight because stem dry weight was recorded more or less same in all the three land configurations. At 80 DAS, ridge & furrow method showed significant difference over the other two land configurations, whereas raised bed and flatbed recorded with at par stem dry weight per plant. Total plant dry weight is a sum total of leaf and stem dry weight at 40 and 80 DAS. The total dry weight/plant was not affected significantly by land configurations but varieties showed significant effect. Accumulation of dry matter in plants is a resultant of various metabolic processes occurring inside. The principal photosynthetic organ responsible for dry matter accumulation is leaves. Varieties significantly influenced total plant dry weight both at 40 and 80 DAS. At both the stages, variety PS-1225 recorded significantly higher total dry matter per plant than the remaining two varieties. While varieties PS-1347 and PS-1092 recorded at par total dry weight per plant. The higher dry matter production was mainly credited to source:sink ratio through better translocation of metabolites and utilization of growth resources.

**Leaf: stem ratio**

Leaf to stem ratio shows the proportion of leaf weight to stem dry weight. At 40 DAS, the ratio was more than 1.0, means the leaf biomass was more than the stem biomass. At later stage, the trend was reverse and proportion of stem weight increased as compared to leaves and the ratio was less than 1.0 irrespective of the treatments. Leaf to stem ratio was not significantly affected by land configurations and varieties at both the stages.

**Root dry weight**

The data pertaining to root dry weight and mean crop growth rate of soybean is given in Table 4. Root dry weight per plant at 40 and 80 DAS was significantly influenced by land configuration and varieties. At 40 DAS, ridge & furrow sowing method recorded highest root dry weight per plant than raised bed and flatbed. Further raised bed method recorded significantly higher root biomass than flatbed method. Among varieties, there was no significant difference for root dry weight, though variety, PS-1225 and PS- 1092 recorded maximum and minimum root dry weight per plant, respectively. At 80 DAS, variety PS-1225 recorded significantly higher root dry weight per plant than other two varieties, whereas var. PS-1092 and PS-1347 were at par to each other in terms of root dry weight. The variation in root growth may be attributed to variable above ground biomass among different varieties.

**Mean crop growth rate**

Crop growth rate was not affected significantly by different land configurations. Upto 40 DAS, the crop growth rate was more or less same in land configurations treatments, while between 40-80 DAS, sowing on ridge method recorded more growth rate followed by flatbed and raised bed methods. Among varieties, during both the periods of CGR determinations, variety PS-1225 recorded significantly higher mean crop growth rate than other two varieties. The mean crop growth rate was statistically at par between varieties PS-1347 and PS-1092.

**Conclusion**

On the basis of experimental findings, it may be concluded that ridge and furrow land configuration performed statistically better than those of flat and raised bed for growth of soybean during *kharif* season. Variety PS-1225 followed by PS-1347 may be adopted for soybean cultivation as these provided better growth than PS-1092.

**Table 1:** Emergence count and plant height of soybean as affected by land configuration and variety

| Treatment | Emergence count/m row | Plant height (cm) | |
|---|---|---|---|
| | 10 DAS | 40 DAS | 80 DAS |
| **Land configuration** | | | |
| Flat bed | 30.3 | 29.9 | 48.7 |
| Ridge & Furrow | 34.3 | 29.1 | 47.6 |
| Raised bed | 33.8 | 31.2 | 49.1 |
| S.Em± | 0.6 | 1.0 | 1.8 |
| CD at 5% | 2.5 | NS | NS |
| **Variety** | | | |
| PS-1092 | 33.4 | 33.4 | 50.2 |
| PS-1225 | 32.2 | 29.9 | 50.1 |
| PS-1347 | 32.8 | 26.9 | 45.0 |
| S.Em± | 0.3 | 0.9 | 1.0 |
| CD at 5% | NS | 2.7 | 3.0 |

**Table 2:** Number of trifoliate and canopy spread under different land configuration and variety

| Treatment | Number of trifoliates per plant | | Canopy spread (cm) | |
|---|---|---|---|---|
| | 40DAS | 80DAS | 40DAS | 80DAS |
| Land configuration | | | | |
| Flat bed | 14 | 19 | 42.2 | 51.5 |
| Ridge & Furrow | 17 | 25 | 42.8 | 52.4 |
| Raised bed | 15 | 17 | 42.7 | 51.5 |
| S.Em± | 1.1 | 1.1 | 0.6 | 1.2 |
| CD at 5% | NS | 4.3 | NS | NS |
| Variety | | | | |
| PS-1092 | 18 | 18 | 42.5 | 52.5 |
| PS-1225 | 17 | 25 | 42.4 | 52.7 |
| PS-1347 | 11 | 18 | 42.8 | 50.2 |
| S.Em± | 1.1 | 1.9 | 0.64 | 1.01 |
| CD at 5% | 4.0 | 6.0 | NS | NS |

**Table 3:** Effect of land configuration and variety on leaf, stem and total plant dry matter and leaf: stem ratio

| Treatment | Leaf dry weight (g/plant) | | Stem dry weight (g/plant) | | Total plant dry weight (g/plant) | | Leaf :Stem ratio | |
|---|---|---|---|---|---|---|---|---|
| | 40 DAS | 80 DAS | 40 DAS | 80 DAS | 40 DAS | 80 DAS | 40DAS | 80DAS |
| Land configuration | | | | | | | | |
| Flat bed | 7.56 | 15.00 | 5.40 | 24.17 | 12.96 | 39.17 | 1.40 | 0.63 |
| Ridge & Furrow | 7.73 | 15.83 | 5.42 | 25.52 | 13.16 | 41.36 | 1.43 | 0.63 |
| Raised bed | 7.63 | 14.68 | 5.61 | 23.59 | 13.25 | 38.27 | 1.36 | 0.63 |
| S.Em± | 0.14 | 0.63 | 0.16 | 0.33 | 0.12 | 0.76 | 0.06 | 0.01 |
| CD at 5% | NS | NS | NS | 1.33 | NS | NS | NS | NS |
| Variety | | | | | | | | |
| PS-1092 | 7.59 | 14.92 | 5.41 | 22.61 | 13.01 | 37.53 | 1.41 | 0.66 |
| PS-1225 | 8.37 | 16.74 | 5.72 | 28.17 | 14.09 | 44.91 | 1.47 | 0.60 |
| PS-1347 | 6.96 | 13.86 | 5.30 | 22.50 | 12.26 | 36.36 | 1.31 | 0.62 |
| S.Em± | 0.16 | 0.42 | 0.19 | 0.71 | 0.27 | 0.78 | 0.05 | 0.03 |
| CD at 5% | 0.49 | 1.31 | NS | 2.21 | 0.86 | 2.44 | NS | NS |

**Table 4:** Root dry matter and mean crop growth rate as affected by land configuration and variety

| Treatment | Root dry weight (g/plant) | | $\overline{\text{CGR}}$ (g/day/plant) | |
|---|---|---|---|---|
| | 40 DAS | 0-40 DAS | 0-40 DAS | 40-80 DAS |
| Land configuration | | | | |
| Flat bed | 0.58 | 1.60 | 0.32 | 0.65 |
| Ridge & Furrow | 0.63 | 1.66 | 0.33 | 0.71 |
| Raised bed | 0.61 | 1.62 | 0.33 | 0.63 |
| S.Em± | 0.01 | 0.02 | 0.003 | 0.02 |
| CD at 5% | 0.02 | NS | NS | NS |
| Variety | | | | |
| PS-1092 | 0.59 | 1.52 | 0.33 | 0.62 |
| PS-1225 | 0.63 | 1.82 | 0.35 | 0.77 |
| PS-1347 | 0.60 | 1.53 | 0.31 | 0.60 |
| S.Em± | 0.02 | 0.02 | 0.01 | 0.02 |
| CD at 5% | NS | 0.07 | 0.02 | 0.07 |

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