

## Growth and Development of Soybean as Influenced by Intercropping with Pigeonpea and Phosphorus Level

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### ABSTRACT

A field study of growth and development of soybean as influenced by intercropping with pigeonpea and phosphorus fertilization revealed that grain yield of soybean due to association of pigeonpea was reduced by 54.96 % in additive and 45.10 % in replacement system of intercropping. A remarkable reduction was noted in harvest index of soybean which was 23.75% in replacement and 19.60% in additive system in comparison to 29.24% in sole cropping. Soybean growth was poor due to association of pigeonpea in additive series. Application of phosphorus showed as positive effect on height of soybean, dry weight, root nodule, number of nodes per plant and other yield attributing characters upto the highest tested dose of 90 kg  $P_2O_5$ /ha. However, grain yield was maximum with the application of 60 kg  $P_2O_5$ /ha @ 4.67 q/ha of 54.11% over control. Optimum level of phosphorus was 61.65 kg  $P_2O_5$ /ha for pure soybean, 36.47 kg  $P_2O_5$ /ha, for inter cropped soybean in additive series and 65.53 kg  $P_2O_5$ /ha in replacement series of intercropping on per row basis.

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### INTRODUCTION

The advantages of intercropping for productive utilization of available resources has been highlighted by Aiyer (1949) and Willey (1979). Intercropping of early maturing pigeonpea and soybean in additive and replacement series is gaining popularity in soybean growing tract of the country. According the Willey (1979), in additive series of intercropping, additional rows and plants of intercrop are adjusted in between two rows of main crop which is sown at wider row spacing. In intercropping of soybean with pigeonpea, most of the research worker have considered pigeonpea as main crop and soybean as intercrop (Ahlawat *et al.* 1982 and Tomar *et al.* 1987). In replacement series of intercropping particular row number of one crop is replaced by suitable number of row

(s) by another crop. In these two crops, research worker have considered both component crop as main and intercrop. In replacement system of intercropping of soybean with pigeonpea, most of the research worker have replaced the row (s) of soybean by pigeonpea (Ahlawat *et al.* 1982 and Billore *et al.* 1993). Phosphorus is one of the most limiting plant nutrients which is essential for good growth and yield of soybean. The doses of phosphorus in intercropping for component crops is still to be decided for soybean in central Uttar Pradesh.

### MATERIALS AND METHODS

The present field investigation was made at Student's Instructional Farm, Chandra Sekhar Azad University of Agriculture and Technology, Kanpur in

Central Uttar Pradesh during 1995-96 and 1996-97 in which 4 cropping systems (sole soybean, sole pigeonpea, two rows of soybean in between 2 rows of pigeonpea in additive and 4 rows of soybean followed by two rows of pigeonpea, in replacement series) was tried under increasing doses of phosphorus (@ 0, 30, 60 and 90 kg  $P_2O_5$ /ha) in a 4 replicated randomized block design. The sowing of kharif crops was done on June 25th during both the years with uniform application of 20 kg N+ 20 kg  $K_2O_5$ /ha. Phosphorus application was done through single super phosphate in rows 40 cm apart using 100 kg seed of JS 72-44 and 16 kg seed of UPAS 120 per hectare in pure cropping of soybean and pigeonpea respectively. While in case of intercropping the seed rate per row was used on the basis of seed rate used in sole cropping. The experimental soil was sandy loam in texture, low in organic carbon (0.47%) and nitrogen (227.3 kg/ha) medium in available P (16.2 kg  $P_2O_5$ /ha) and potash (120 kg/ha) with slightly alkaline in reaction (pH 7.6).

## RESULTS AND DISCUSSION

### Effect of pigeonpea on soybean in intercropping

Soybean was grown in association of pigeonpea in additive 2:1 and in replacement series 4:2 and its growth and yield was compared with its pure stand which has been presented in Table 1. It is evident from the data that initial plant population of soybean in additive and replacement series was 100% and 65.33% in comparison to 100% in sole soybean. But at the time of harvesting, plant population of soybean was 72.14 % and 66.58 % in additive and replacement series in comparison to 100% in sole soybean.

The rate of mortality of plants was 32.61% in additive and 4.96% in replacement system while it was only 6.61% in pure soybean. It is thus clear that in additive series pigeonpea exerted greater adverse effect on soybean plants than replacement series in which the adverse effect of pigeonpea was observed only in adjoining rows (50 %). This might be due to teletoxic association of pigeonpea with soybean. The various observations on growth parameters like number of nodes, pod bearing nodes and number of nodes per root clearly indicated that there was etiolated growth of shoot of soybean particularly in additive series in association with pigeonpea in comparison to pure soybean. The root excreted chemical compound of pigeonpea might be responsible for etiolated growth of soybean. Etiolated growth of shoot was also responsible for poor development on reproductive organs like, increase in height of first pod bearing node and reduction in pod bearing nodes, number of pods per bearing node, pod yield per plant, number of pods per plant and number of seed per pod (Cf Table 1). Consequently seed yield per plant in association of pigeonpea was reduced by 41.77% and 13.81% in additive and replacement series in comparison to pure soybean.

The reduction in grain and crop shoot biomass yield in association of pigeonpea particularly in additive system is explained on the basis of combined effect of reduction in final plant population and poor development of pods and grains. Grain yield of soybean in additive and replacement series was 45.05 % and 55.09 % in comparison to 100 % in sole soybean. The

TABLE 1

Growth and yield contributing characters of soybean as influenced by intercropping with pigeonpea and phosphorus level.

| (2 year pooled)                              |                            |        |                |                                               |                          |                                 |                                                |                                   |                              |                               |                                   |                                 |                          |       |
|----------------------------------------------|----------------------------|--------|----------------|-----------------------------------------------|--------------------------|---------------------------------|------------------------------------------------|-----------------------------------|------------------------------|-------------------------------|-----------------------------------|---------------------------------|--------------------------|-------|
| Treatments                                   | Plant population<br>000 ha |        | Mortality<br>% | Number of<br>nodule<br>per plant<br>at 60 DAS | Branches<br>per<br>plant | Number<br>of nodes<br>per plant | Number<br>of pod<br>bearing nodes<br>per plant | Number<br>of pods<br>per<br>plant | Number<br>seeds per<br>plant | Pod yield<br>per plant<br>(g) | Seed<br>yield<br>per plant<br>(g) | Crop shoot<br>biomass<br>(q) ha | Grain<br>yield<br>(q/ha) | HI %  |
|                                              | Initial                    | Final  |                |                                               |                          |                                 |                                                |                                   |                              |                               |                                   |                                 |                          |       |
| Cropping System                              |                            |        |                |                                               |                          |                                 |                                                |                                   |                              |                               |                                   |                                 |                          |       |
| Sole Soybean                                 | 387.18                     | 361.29 | 6.61           | 12.19                                         | 4.02                     | 16.65                           | 8.47                                           | 58.69                             | 69.95                        | 12.16                         | 5.65                              | 60.02                           | 17.65                    | 29.24 |
|                                              | (100%)                     |        |                |                                               |                          |                                 |                                                |                                   |                              |                               |                                   | (100%)                          | (100%)                   |       |
| Soybean + Pigeonpea                          | 387.27                     | 260.64 | 32.61          | 8.35                                          | 2.98                     | 15.94                           | 7.55                                           | 41.69                             | 44.75                        | 7.76                          | 3.29                              | 38.14                           | 7.95                     | 19.60 |
| (2:1) Additive                               | (100%)                     |        |                |                                               |                          |                                 |                                                |                                   |                              |                               |                                   | (45.05%)                        | (45.04%)                 |       |
| Soybean + Pigeonpea                          | 252.95                     | 240.56 | 4.96           | 12.35                                         | 3.36                     | 16.20                           | 7.43                                           | 53.12                             | 62.76                        | 10.48                         | 4.87                              | 40.56                           | 9.69                     | 23.75 |
| (4:2) replacement                            | (65.33%)                   |        |                |                                               |                          |                                 |                                                |                                   |                              |                               |                                   | (55.09%)                        | (54.97%)                 |       |
| SE (d)                                       | 1.269                      | 1.551  | 0.468          | 0.313                                         | 0.110                    | 0.296                           | 0.186                                          | 0.270                             | 1.05                         | 0.270                         | 0.080                             | 0.765                           | 0.266                    | 0.612 |
| Cd at 5%                                     | 2.535                      | 3.096  | 0.935          | 0.623                                         | 0.219                    | 0.591                           | 0.371                                          | 0.539                             | 2.105                        | 0.539                         | 0.159                             | 1.528                           | 0.531                    | 1.223 |
| Doses of P <sub>2</sub> O <sub>5</sub> kg/ha |                            |        |                |                                               |                          |                                 |                                                |                                   |                              |                               |                                   |                                 |                          |       |
| 0                                            | 341.01                     | 287.41 | 14.41          | 8.34                                          | 2.49                     | 16.01                           | 6.58                                           | 40.28                             | 43.91                        | 7.85                          | 3.42                              | 36.24                           | 8.63                     | 22.84 |
| 30                                           | 342.81                     | 286.89 | 14.98          | 11.27                                         | 3.51                     | 16.23                           | 7.97                                           | 51.26                             | 59.12                        | 10.21                         | 4.59                              | 46.61                           | 11.76                    | 24.12 |
| 60                                           | 342.82                     | 286.93 | 14.91          | 12.39                                         | 3.73                     | 16.32                           | 8.12                                           | 55.91                             | 66.37                        | 11.25                         | 5.19                              | 50.72                           | 13.30                    | 24.98 |
| 90                                           | 343.23                     | 288.76 | 14.58          | 12.38                                         | 3.98                     | 16.49                           | 8.62                                           | 56.40                             | 66.51                        | 11.22                         | 5.22                              | 51.38                           | 13.39                    | 24.93 |
| SE (d)                                       | 1.466                      | 1.791  | 0.541          | 0.362                                         | 0.127                    | 0.342                           | 0.216                                          | 1.081                             | 1.218                        | 0.312                         | 0.093                             | 0.883                           | 0.307                    | 0.707 |
| CD at 5%                                     | NS                         | NS     | NS             | 0.723                                         | 0.253                    | NS                              | 0.429                                          | 2.158                             | 2.431                        | 0.623                         | 0.185                             | 1.764                           | 0.614                    | 1.412 |

( ) Figure's are % over sole corpping.

adverse effect of pigeonpea on growth and yield attributes and also on yield of soybean has also been reported by a number of research workers in additive series (Saxena and Yadav 1976 and Nimje 1995) and in replacement series (Nimje 1995 and Jadhao *et al.* 1992).

### Effect of phosphorus on growth and development of soybean

Perusal of the results in Table - 1 make it clear that phosphorus had little effect on initial and final plant stand of soybean which is because of the fact that in the field conditions, phosphorus has no effect either on germination or on mortality of plants. The majority of yield contributing characters were found significant upto 60 kg  $P_2O_5$ /ha. The grain yield of soybean was found to be increased with the application of phosphorus upto 60 kg  $P_2O_5$ /ha and quadratic regression equation indicated that for maximum yield of soybean required 76.22

kg  $P_2O_5$ /ha. Grain yield per plant was also increased in a linear manner upto 60 kg  $P_2O_5$ /ha which was governed by positive effect of P on number of grains per plant and their size. Number of grains per plant was increased because of increase in number of pods per plant and seed per pod. While number of pods per plant was increased due to increase in the number of pod bearing nodes per plant. Similar findings was also reported by Nimje (1995).

Phosphorus requirement of soybean in pure and in association of pigeonpea. Data presented in Table-2 reveals that the response of soybean to the application of phosphorus was different in pure and in intercropping sequences. Optimum level of phosphorus in pure soybean was worked out as 61.65 kg  $P_2O_5$ /ha while it was 36.47 kg  $P_2O_5$ /ha in additive series and 65.53 kg  $P_2O_5$ /ha in replacement series on row basis.

TABLE 2

Regression equation, X-maximum and X-optima, yield and response per unit of P and per rupee spent on P in soybean in pure and with pigeonpea.

| Cropping Systems                 | Regression equation     | X-maxima<br>kg $P_2O_5$ /ha | X-optima<br>kg $P_2O_5$ /ha | Yield at<br>xmaxima<br>q/ha | (For pooled data)                       |                                                |
|----------------------------------|-------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------------------|------------------------------------------------|
|                                  |                         |                             |                             |                             | Response<br>kg Grain/kg<br>$P_2O_5$ /ha | Response<br>Rs./Rs.<br>invested<br>on $P_2O_5$ |
| C1-Sole Soybean                  | $Y=12.70+6.01x-1.16x^2$ | 77.69                       | 61.65                       | 20.48<br>(100%)             | 40.81                                   | 32.90                                          |
| C3-Soybean +<br>Pigeonpea (2:1)  | $Y=6.01+2.76x-0.63x^2$  | 66.13                       | 36.47                       | 7.31<br>(35.67%)            | 21.66                                   | 16.38                                          |
| C-4 Soybean +<br>Pigeonpea (4:2) | $Y=6.97+3.15x-0.57x^2$  | 82.48                       | 65.53                       | 11.30<br>(55.17%)           | 20.25                                   | 16.38                                          |
| Main effect of<br>phosphorus     | $Y=8.64+3.86x-0.76x^2$  | 76.22                       | 51.79                       | 13.54                       | 26.66                                   | 21.60                                          |

Where x = is the interval between two phosphorus doses (i.e. 30 kg  $P_2O_5$ /ha).  
Y = grain yield q/ha.

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