Influence of Planting Patterns and Intercropping on Growth and Yield of suru sugarcane (Saccharum officinarum L.)

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A field experiment was carried out at Agronomy Farm, College of Agriculture, Pune (Maharashtra) during spring season of 2011-12 to find out the effect of different planting methods along with intercropping on growth and yield of suru sugarcane (Saccharum officinarum L.) Var. Co 86032. The experiment was comprising of four planting patterns viz., 90 x 30 cm single row planting, 90-180 x 30 cm paired row planting, 180 x 30 cm single row planting and 120 x 30 cm single row planting with sugarcane planter as main plots and two intercropping systems viz., sugarcane + groundnut and sole sugarcane, laid out in strip plot design with three replications in medium deep black, well drained, clayey textured soils with alkaline reaction (pH 7.6). The field capacity and permanent wilting point values were 36.07 and 18.45 per cent, respectively. The bulk density was 1.21 g cm⁻³. In single row planting system, single line of groundnut (TPG 41) was sown in inter-row space of sugarcane on one side of ridge and in paired row planting and in wide row planting two rows of groundnut was sown in inter-row space of sugarcane.

Results revealed that intercropping of two rows of groundnut in paired row planting of sugarcane (2:2) was proved to be the most productive system with significantly the highest cane equivalent yield (152 96 t ha⁻¹). The treatment combination of paired row planting of sugarcane at 90-180 x 30 cm associated with groundnut in 2:2 ratio was also found to be the most remunerative.

**Keywords:** CEY, intercropping, planting pattern, Suru sugarcane.

The population per unit area and distance between cane rows play a significant role in influencing the yield. Wide row sugarcane planting technology is spreading fast particularly in tropical states (Sundara, 2002) to facilitate mechanical harvesting of the crop. The larger interspaces between the wide spaced sugarcane rows can be utilized by the intercrops for better exploitation of the natural resources like light, soil moisture, nutrients and carbon dioxide. Sugarcane is generally planted as sole crop in spring season. The slow establishment of sugarcane during the initial period and adoption of comparatively wider row spacing offers vast scope for intercropping. Temporal differences can be best exploited by using species or varieties of intercrops that are sufficiently early maturing and harvested before they compete with cane may provide ample opportunity for intercropping of summer crops, particularly in suru season which replaced at the rate of 25% in Maharashtra each year (Verma and Yadav, 1986).
Intercropping in spring sugarcane with legume is quite a common practice and has been recognized as potential system to enhance the productivity of sugarcane based cropping systems (Anon. 2015). There is need for better management and the selection of suitable intercrop for local conditions necessitate for harnessing maximum benefits and sustaining soil health. With the introduction of high tillering and high yielding varieties of sugarcane, it is possible to maintain the cane population and final cane yield even at relatively wider row spacing. Increasing the row spacing of sugarcane from the present recommended spacing of 90 to 120 cm would greatly facilitate not only easy management of intercropping without any competition effects, but also provide enough scope for intercrops to get higher productivity, especially under frequently irrigated tropical climatic regions. (Shahi, 2002). In light of this back ground, present experiment was conducted to find out the effect of planting pattern and intercropping with groundnut on growth and yield of suru sugarcane var. Co-86032.

MATERIALS AND METHODS

The field experiment was conducted at Agronomy Farm, College of Agriculture, Pune during spring season of 2011-12 to find out the influence of different planting patterns along with intercropping on growth and yield of suru sugarcane (Saccharum officinarum L.) Var. Co-86032 on medium deep black, well drained, clayey textured soils found low in available N (143 kg ha⁻¹), medium in available P (16.5 kg ha⁻¹), high in available K (416 kg ha⁻¹), moderately high organic carbon content (0.72 %) with low EC (0.24 dSm⁻¹) and alkaline in reaction (pH 7.6) with 36.07 % field capacity, 18.45 % permanent wilting point and 1.21 g cm⁻³ bulk density.

The experiment was laid out in strip plot design with three replications. The treatment was consisted of four planting patterns viz., 90 x 30 cm single row planting (P₁), 90-180 x 30 cm paired row planting (P₂), 180 x 30 cm single row planting (P₃) and 120 x 30 cm single row planting with sugarcane planter (P₄) as main plots and two intercropping systems viz., sugarcane + groundnut (I₁) and sole sugarcane (I₂). In single row planting system, single line of groundnut (TPG 41) was sown in inter-row space of sugarcane on one side of ridge, whereas, in paired row as well as in wide row planting two rows of groundnut was sown in inter-row space of sugarcane. The recommended dose of 250:115:115 kg N, P₂O₅ and K₂O ha⁻¹ to spring sugarcane and 25 kg N and 50 kg P₂O₅ ha⁻¹ to groundnut was applied through urea, single super phosphate and muriate of potash, respectively. In sugarcane nitrogen was given in four splits. The 1st 10 per cent (25 kg N ha⁻¹) at the time as planting, 2nd 40 per cent (100 kg N ha⁻¹) after 45 DAP at tillering stage, 3rd 10 per cent (25 kg N ha⁻¹) after 90 DAP at light earthing up and remaining 40 per cent (100 kg N ha⁻¹) after 120 DAP at the time of final earthing up. The P₂O₅ and K₂O fertilizers were applied in two equal splits i.e. 50 % as a basal dose at planting and remaining 50% as top dressing at final earthing up. 40 % of recommended fertilizer (25-50-00 kg NPK ha⁻¹) was applied to groundnut separately as an intercrop i.e. 10 kg N ha⁻¹ in two equal splits at planting and one month after planting and full dose of 20 kg P₂O₅ ha⁻¹ was applied as basal dose.

RESULTS AND DISCUSSION

Effect of planting patterns

Data depicted in fig.1 showed that the initial plant population of sugarcane was not affected extensively due to different treatments of planting patterns, but the maximum plant population was observed at 90 x 30 cm single row planting (26379 ha⁻¹) as compared to other planting patterns. But planting pattern had perceptible influence on survival percentage and significantly higher survival percentage (75.71 %) was observed in paired row planting of 90-180 x 30 cm as compared to other planting patterns. It was also further revealed that significantly the highest plant height (312.12 cm), number of leaves per shoot available for the purpose of photosynthesis production under paired row planting two rows of groundnut as compared to single row planting resulted in to higher number of leaves per shoot available for the purpose of photosynthesis production under paired row planting (More, 2003). Nevertheless, periodical
number of tillers clump\(^{-1}\) (Fig.2), dry matter accumulation, mean girth of cane and number of internodes plant\(^{-1}\) (Table-1) were not affected markedly due to different planting patterns. Similar results were also reported by Raskar and Bhoi (2003) and Gulati et al. (2015). Yield attributes shown in table-2 revealed that number of millable cane (927800 ha\(^{-1}\)) was found significantly higher under \(P_1\), i.e. single row planting with 90 x 30 cm, however, it was found at par with \(P_2\), i.e. paired row planting of 90-180 x 30 cm spacing (91020 ha\(^{-1}\)). Chaudhari et al. (2014) and Kumawat and Dahima (2016) also observed that millable cane population was the highest under normal row spacing (90 cm) and was reduced under wider row spacing of 150 cm.

Conversely, being at par with 180 x 30 cm single row \((P_3)\), appreciably higher average cane weight \((1.45 \text{ kg plant}^{-1})\) was recorded under paired row planting of 90-180 x 30 cm spacing \((P_2)\). The higher cane weight in paired row planting might be due to increase in number of internodes and length of internodes, millable height of cane, respectively. An outright increase in cane yield \((131.95 \text{ t ha}^{-1})\), commercial cane sugar \((19.21 \text{ t ha}^{-1})\) yield and cane equivalent yield \((143.91 \text{ t ha}^{-1})\) was reported in paired row planting of 90-180 x 30 cm spacing \((P_2)\). In paired row planting, main factors contributing towards cane yield was number of internodes and length of internodes, millable height of cane and weight of cane. Similar findings were reported by More (2003) and Anon. (2015).

Different planting patterns of sugarcane did not exert any significant influence on the yield and yield attributes of groundnut as an intercrop indicating non-detrimental impact of sugarcane on growth and development of groundnut (Table-3).

**Effect of intercrop**

Intercropping of sugarcane with groundnut had remarkable influence on survival percentage, plant height and number of leaves plant\(^{-1}\) of sugarcane and remarkably less survival percentage (72.39%), plant height (304.85 cm) and number of leaves plant\(^{-1}\) (7.57) were reported when sugarcane was intercropped with groundnut \((I_1)\) compared to sole sugarcane \((I_2)\). Numbers of tillers per clump, mean girth of cane, number of internodes per plant, length of internodes, millable cane height as well as number of millable canes ha\(^{-1}\) were not influenced significantly due to intercrops.
| Treatments | Survival % | Plant Height (cm) | Number of leaves plant\(^1\) | Dry matter accumulation (g) | Girth (cm) | Number of Internodes plant\(^1\) | Length of Internodes (cm) | Millable cane height (cm) |
|------------|------------|------------------|-----------------------------|-----------------------------|------------|-----------------------------|-------------------------|-------------------------|
| **Planting patterns** | | | | | | | | |
| P\(_1\): 90 x 30 cm single row | 71.22 | 300.63 | 7.39 | 549.49 | 8.70 | 22.49 | 19.06 | 263.07 |
| P\(_2\): 90-180 x 30 cm paired row | 75.71 | 312.12 | 7.69 | 552.00 | 8.92 | 23.18 | 20.13 | 276.70 |
| P\(_3\): 180 x 30 cm single row | 75.36 | 306.39 | 7.57 | 553.49 | 8.96 | 23.01 | 19.76 | 271.29 |
| P\(_4\): 120 cm single row with sugarcane planter | 68.78 | 303.94 | 7.50 | 551.16 | 8.87 | 22.89 | 19.37 | 267.26 |
| SEM \(\pm\) | 0.31 | 0.63 | 0.03 | 1.78 | 0.02 | 0.63 | 0.12 | 1.08 |
| CD at 5 % | 1.06 | 2.19 | 0.09 | NS | NS | NS | 0.42 | 3.73 |
| **Intercrops** | | | | | | | | |
| I\(_1\): Sugarcane + Groundnut | 72.39 | 304.85 | 7.51 | 548.49 | 8.89 | 22.78 | 19.48 | 268.59 |
| I\(_2\): Sole Sugarcane | 73.14 | 306.69 | 7.57 | 554.58 | 8.84 | 23.00 | 19.69 | 270.57 |
| SEM \(\pm\) | 0.35 | 0.47 | 0.01 | 1.39 | 0.02 | 0.40 | 0.10 | 0.74 |
| CD at 5 % | 1.13 | 1.53 | 0.04 | 4.56 | NS | NS | NS | NS |
| **Interaction** | | | | | | | | |
| SEM \(\pm\) | 0.69 | 0.94 | 0.02 | 2.78 | 0.04 | 0.79 | 0.20 | 1.49 |
| CD at 5 % | NS | NS | NS | NS | NS | NS | NS | NS |
| **Mean** | 72.77 | 305.77 | 7.54 | 551.54 | 8.86 | 22.89 | 19.58 | 269.58 |
The dry matter accumulation per plant in sugarcane at harvest (554.58 g) was significantly more in sole planted sugarcane than groundnut intercropped cane. The differences in weight of individual cane (1.36 kg cane\(^{-1}\)), mean cane yield \((112.15 \text{ t ha}^{-1})\) and CCS \((16.09 \text{ t ha}^{-1})\) were differed significantly due to intercrops and it was found maximum with sole sugarcane than groundnut intercropped cane. The cane yield decreased by 4.89 per cent with intercropping of groundnut compared with sole sugarcane. Contrary to this, significantly higher cane equivalent yield \((131.61 \text{ t ha}^{-1})\) was recorded by groundnut intercropped sugarcane than sugarcane alone \((116.59 \text{ t ha}^{-1})\) and it was 12.88 per cent higher than sole planting of sugarcane. This might be owing to additional yield obtained

### Table 2. Yield attributes, yield and Cane equivalent yield of sugarcane as affected by different treatments

| Treatment | NMC\(^1\) \(\left(10^6 \text{ kg ha}^{-1}\right)\) | ACW\(^2\) (kg) | Cane yield \(\text{ t ha}^{-1}\) | CCS\(^3\) yield \(\text{ t ha}^{-1}\) | CEY\(^4\) \(\text{ t ha}^{-1}\) |
|-----------|-----------------|-------------|----------------|----------------|-----------------|
| Planting patterns | | | | | |
| P\(_1\): 90 x 30 cm single row | 92.78 | 1.11 | 102.55 | 14.51 | 118.91 |
| P\(_2\): 90-180 x 30 cm paired row | 91.02 | 1.45 | 131.95 | 19.21 | 143.91 |
| P\(_3\): 180 x 30 cm single row | 59.99 | 1.42 | 85.17 | 11.63 | 106.04 |
| P\(_4\): 120 cm single row with sugarcane planter | 86.06 | 1.37 | 117.91 | 17.13 | 127.55 |
| SEm + | 1.16 | 0.01 | 1.36 | 0.16 | 2.19 |
| CD at 5 % | 4.02 | 0.04 | 4.70 | 0.57 | 7.59 |
| Intercrops | | | | | |
| I\(_1\): Sugarcane + Groundnut | 81.65 | 1.31 | 106.67 | 15.16 | 131.61 |
| I\(_2\): Sole Sugarcane | 83.26 | 1.36 | 112.15 | 16.09 | 116.59 |
| SEm + | 0.89 | 0.01 | 1.49 | 0.22 | 0.99 |
| CD at 5 % | NS | 0.04 | 4.87 | 0.73 | 3.25 |
| Interaction | | | | | |
| SEm + | 1.79 | 0.02 | 2.99 | 0.45 | 1.99 |
| CD at 5 % | NS | NS | NS | NS | 8.95 |
| Mean | 82.46 | 1.34 | 109.39 | 15.62 | 124.10 |

\(^1\)Number of milleable canes, \(^2\)Average cane weight, \(^3\)Commercial cane sugar, \(^4\)Cane equivalent yield

### Table 3. Ancillary observations of Groundnut as influenced by various treatments of sugarcane planting patterns

| Treatment | Plant height (cm) | Plant spread (cm) | Filled pods / plant | Un filled pods / plant | Pod weight / plant (g) | Kernel weight / plant (g) | Dry pod yield (q/ha) |
|-----------|------------------|------------------|---------------------|-----------------------|------------------------|--------------------------|----------------------|
| P\(_1\): 90 x 30 cm single row | 25.78 | 30.02 | 14.18 | 3.78 | 28.88 | 18.02 | 9.93 |
| P\(_2\): 90-180 x 30 cm paired row | 26.40 | 32.51 | 16.70 | 4.34 | 30.58 | 20.33 | 13.76 |
| P\(_3\): 180 x 30 cm single row | 26.23 | 32.47 | 16.43 | 4.25 | 30.59 | 19.89 | 13.07 |
| P\(_4\): 120 cm single row with sugarcane planter | 26.05 | 32.18 | 14.99 | 4.01 | 29.36 | 18.44 | 11.10 |
| SEm + | 0.10 | 0.11 | 0.07 | 0.08 | 0.07 | 0.09 | 0.11 |
| CD 5% | NS | NS | NS | NS | NS | NS | NS |
| General Mean | 26.12 | 31.79 | 15.57 | 4.10 | 29.83 | 19.17 | 11.17 |
### Table 4. Interaction effects of planting patterns and intercrop on cane equivalent yield

| Treatment                                        | cane equivalent yield (t ha\(^{-1}\)) |
|--------------------------------------------------|---------------------------------------|
|                                                  | Sugarcane + groundnut | Sole sugarcane |
| **Planting patterns**                            |                         |                |
| P\(_1\): 90 x 30 cm single row                   | 123.04                  | 114.77         |
| P\(_2\): 90-180 x 30 cm paired row               | 152.96                  | 134.86         |
| P\(_3\): 180 x 30 cm single row                  | 115.50                  | 96.58          |
| P\(_4\): 120 cm single row with sugarcane planter | 134.94                  | 120.15         |
| SEm ±                                            |                          | 1.99           |
| CD at 5 %                                        |                          | 8.95           |

### Table 5. Economics of sugarcane as influenced by various treatments

| Treatments                                         | Gross Monitory returns (' ha\(^{-1}\)) | Cost of cultivation (' ha\(^{-1}\)) | Net realization (' ha\(^{-1}\)) | B:C |
|----------------------------------------------------|----------------------------------------|------------------------------------|---------------------------------|-----|
| **Planting patterns**                              |                                        |                                    |                                 |     |
| P\(_1\): 90 x 30 cm single row                     | 136742                                 | 56019                             | 80723                           | 2.44|
| P\(_2\): 90-180 x 30 cm paired row                 | 165496                                 | 53372                             | 112125                          | 3.10|
| P\(_3\): 180 x 30 cm single row                    | 121946                                 | 51701                             | 70245                           | 2.35|
| P\(_4\): 120 cm single row with sugarcane planter  | 146679                                 | 52536                             | 94143                           | 2.79|
| SEm ±                                              | 2521                                   | 132                               | 2497                            | 0.05|
| CD at 5 %                                          | 8726                                   | 457                               | 8641                            | 0.16|
| **Intercrops**                                     |                                        |                                    |                                 |     |
| I\(_1\): Sugarcane + Groundnut                     | 151354                                 | 55262                             | 96092                           | 2.74|
| I\(_2\): Sole Sugarcane                           | 134078                                 | 51552                             | 82526                           | 2.60|
| SEm ±                                              | 1146                                   | 80                                | 1136                            | 0.02|
| CD at 5 %                                          | 3738                                   | 261                               | 3705                            | 0.07|
| **Interaction**                                    |                                        |                                    |                                 |     |
| SEm ±                                              | 2292                                   | 160                               | 2272                            | 0.04|
| CD at 5 %                                          | NS                                     | NS                                | NS                              | NS  |
| Mean                                               | 142716                                 | 53407                             | 89309                           | 2.67|

### Table 6. Interaction effect between planting patterns and intercrop on net realization (' ha\(^{-1}\))

| Treatment                                          | Intercrop |                      |                  |
|----------------------------------------------------|-----------|-----------------------|------------------|
|                                                    | Sugarcane + groundnut | Sole sugarcane     |                  |
| **Planting patterns**                              |           |                       |                  |
| P\(_1\): 90 x 30 cm single row                     | 83576     | 77871                 |                  |
| P\(_2\): 90-180 x 30 cm paired row                 | 120628    | 103622                |                  |
| P\(_3\): 180 x 30 cm single row                    | 79220     | 61271                 |                  |
| P\(_4\): 120 cm single row with sugarcane planter  | 100945    | 87341                 |                  |
| SEm ±                                              | 2272      |                       |                  |
| CD at 5 %                                          | 10223     |                       |                  |
from groundnut and attractive price of their pods in market. These results corroborated the findings of Kumar et al. (2006).

**Interaction effect**

The combined effect (Table-4) of planting patterns and intercrop clearly indicates that significantly maximum sugarcane equivalent yield (152.96 t ha⁻¹) and higher net monetary returns (120628 ha⁻¹) were obtained from paired row planting at 90-180 x 30 cm (P₂) accommodating two rows of groundnut in skip row as an intercrop (I₁) over rest of the combinations. The sugarcane + groundnut intercropping recorded 13.42 per cent higher CEY over sole sugarcane in paired row planting.

**Economics**

The operational cost required for planting of sugarcane at 90 x 30 cm single row planting and 90-180 x 30 cm paired row planting were 56019 and 53372 ha⁻¹, respectively. The gross monetary returns (165496 ha⁻¹), net monetary returns (112125 ha⁻¹) and B:C ratio (3.1) were significantly higher at paired planting of 90-180 x 30 cm spacing (P₂) than rest of the treatments. The planting of cane at 90-180 x 30 cm recorded 21.02 per cent higher monetary returns over 90 x 30 cm, 35.71 per cent over 180 x 30 cm and 12.83 per cent over 120 cm with sugarcane planter.

The sugarcane planted with groundnut registered significantly higher gross monetary returns (151354), net monetary returns (96092) and B:C (2.74) ratio than sole sugarcane.

The combined effect of planting patterns and intercrop clearly indicated that sugarcane + groundnut intercropping in paired row planting recorded 16.41 per cent higher than sole sugarcane in paired row planting.

**CONCLUSIONS**

In light of the above discussion it can be concluded that intercropping of two rows of groundnut in paired row planting of sugarcane at 90-180 x 30 cm spacing was proved to be the most productive system. Considering the net monetary returns in paired row planting of sugarcane at 90-180 x 30 cm associated with groundnut in 2:2 ratio was found to be most remunerative.

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